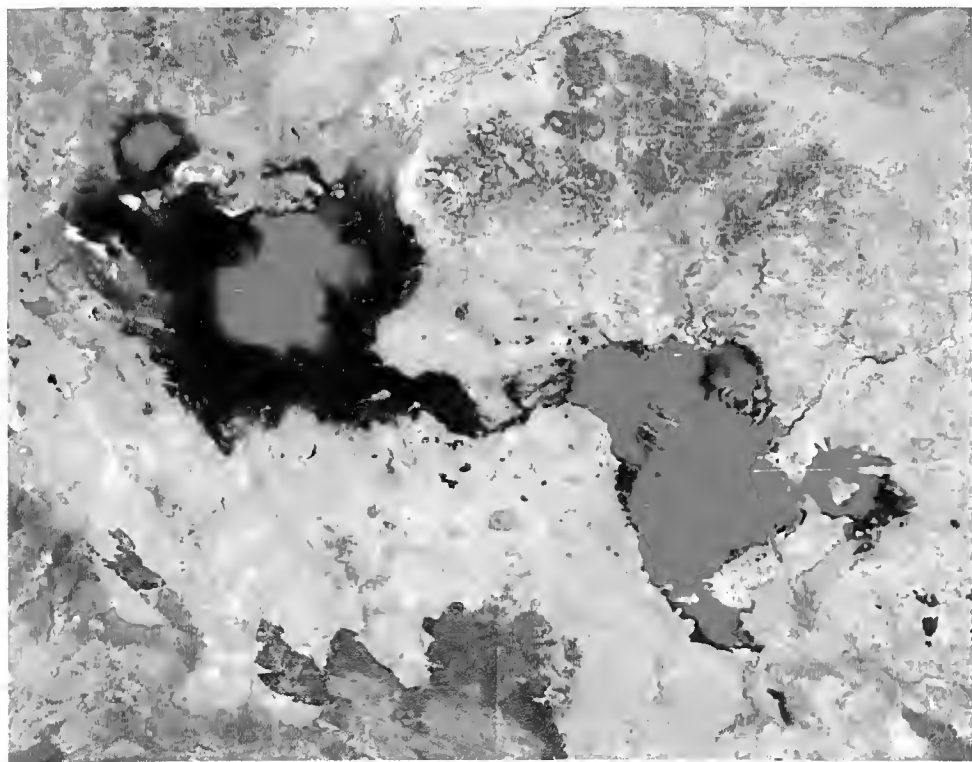


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Front Cover:: A satellite view of the huge intermittent lakes in the Barkly Tableland in April 2001 (see articles by R. Jaensch). At this time the lakes' extent was close to the largest ever observed, with the Sylvester and Tarrabool complexes connecting. This image is approximately 180km wide. (Geoscience Australia)

Rear Cover: The Black-footed Tree-rat *Mesembriomys gouldii* is a large and distinctive arboreal rodent found in Top End forests - see the Species Profile in this issue. (Martin Armstrong)

Vertebrate pollinators visit flowers of an Umbrella Tree *Schefflera actinophylla* almost exclusively in the afternoon

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Abstract

Quantified observations of use of the flowers of a large cultivated specimen of the Umbrella Tree *Schefflera actinophylla* by potential pollinators show that the flowers were visited by a range of birds, and occasionally by a Black Flying Fox *Pteropus alecto*, but almost always in the afternoon from about 1400 hours until sundown. This pattern is consistent with previous and other anecdotal observations. There was no evidence of the characteristically noisy aggregations of flying foxes at the flowers at night. Most bird-pollinated flowers secrete nectar, and are visited by birds, in the morning or throughout the day. The apparently unusual pattern exhibited by this Umbrella Tree might be explained as a response to competition for pollinators, but further study is required to confirm the generality and significance of the pattern.

Introduction

Plants provide nectar as one of several possible rewards for the animals that effect their pollination. However, they do not do so indiscriminately. One of many parameters of nectar secretion that may be optimised to the plant's needs is its timing so that availability corresponds with and/or manipulates the activities of pollinating agents. The flowers of plants specialised for pollination by birds typically open and/or commence nectar secretion shortly before dawn, those for diurnal insects later in the day when it is warmer, and those specialised for pollination by bats or nocturnal moths at about dusk (Cruden *et al.* 1983, Bawa 1990). For example, the south-east Australian mistletoe *Ameyma pendulum* has flowers with a narrow, tubular corolla such that the nectar is accessible only to birds, and nectar is secreted from dawn to about midday (Bernhardt & Calder 1981). In contrast, the Queensland rainforest tree *Syzygium cormiflorum* has a generalised pollination syndrome with open flowers, secretes nectar throughout the day and night and is pollinated by birds, blossom-bats and insects (Crome & Irvine 1986).

The Umbrella Tree *Schefflera actinophylla* is a small tree of tropical rainforests in Queens-

land, the Northern Territory and New Guinea. Its flowers attract a range of nectarivorous birds, as reported for both natural occurrences (Brown & Hopkins 1995, Franklin 1998) and plants in cultivation (Jones 1986, Brock 1993, Franklin 1998). Anecdotal observations, however, suggest that the Umbrella Tree is visited by birds mainly in the afternoon (Franklin 1998). The flowers of the Umbrella Tree are pink or red, a colour often associated with bird or butterfly pollination (Faegri & van der Pijl 1979). The flowers are apparently odourless, also characteristic of bird pollination syndromes. On the other hand, the large, robust and terminally-displayed inflorescences and small open flowers suggest adaptation to pollination by a range of animals and perhaps by bats in particular.

This combination of traits and patterns of usage raises questions about the pollinators and pollination adaptations of the Umbrella Tree. There appear to be no previous studies of the pollination biology of any species of *Schefflera*. In this note, I quantify temporal (daytime) patterns of use of the flowers of a single cultivated specimen during its 2000-01 flowering season. The specimen is the same tree that was the primary source of my earlier (1997-98 flowering season) observations. I also extend the consideration of vertebrate flower visitors by examining whether the late afternoon floral visitation is a prelude to evening visitation by flying foxes.

Methods

The study was conducted from 6 January to 19 February 2001, peak flowering time for the large (10 m tall) study specimen at Nightcliff (12° 23' S, 130° 51' E), a leafy, coastal suburb of Darwin. The specimen was growing in a well-treed home garden comprising a diverse mix of palm and non-palm tree species. Most observations were made on nine days dispersed throughout the study period, these observations being supplemented on other days throughout the study period to ensure more or less even coverage of all times of the day. I did not collect data if it was raining.

Observations consisting of instantaneous scan counts of the fauna feeding at the inflorescences were made on the hour in daylight hours. The scans were conducted from the second floor of a block of flats, which placed me at approximately eye level with, and about 30 m from the flowers, a good distance for observing birds but too far away to identify and frequently to even locate invertebrate visitors. I had a clear view of the majority of inflorescences, but some were partly obscured by foliage. I also counted the number of inflorescences in use.

The inflorescences were not visible after dark, being shaded from street lights. On 17 occasions (2000 hrs - 8 evenings; 2100 hrs - 7 evenings; 2200 hrs - 2 evenings) dispersed through the study period I listened for activity at the inflorescences and watched and listened for activity in nearby areas for 1 minute with the aim of detecting the

presence of flying foxes *Pteropus* spp.

Results

The Umbrella Tree produced about ten inflorescences during the study period, with generally between three and seven in use on a scan when vertebrates were foraging. Vertebrates were recorded feeding at these inflorescences during 40 of the 99 daylight scans. These records were, with one exception, entirely between 1400 and 1900 hours (Fig. 1), a time subsequently referred to as the *vertebrate activity period*.

The vertebrates recorded feeding at the Umbrella Tree flowers during daylight hours comprised one parrot, seven honeyeater and one flying fox species (Table 1). The White-gaped Honeyeater *Lichenostomus unicolor* was recorded both most frequently and most abundantly, followed by the Rainbow Lorikeet *Trichoglossus haematodus*. In addition to the two diurnal scan observations, I also observed a Black Flying Fox *Pteropus alecto* foraging at the flowers in daylight hours on two other occasions. These four observations were all of one individual, were on four different days, and occurred between 1650 and 1900 hours.

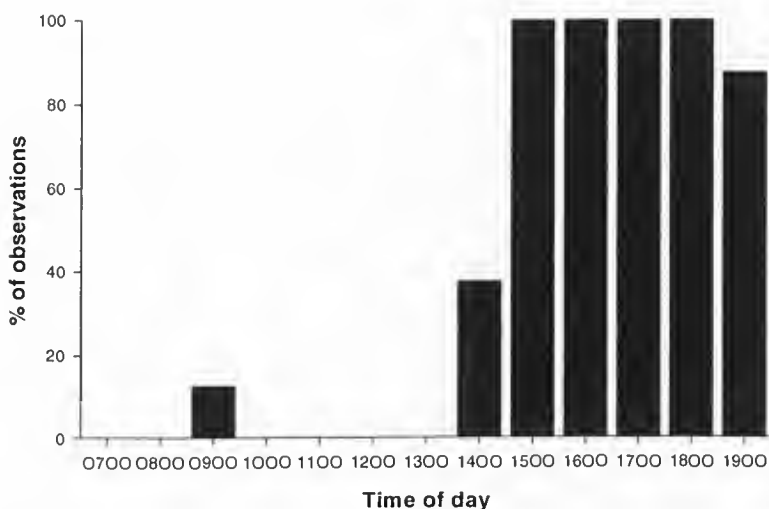


Figure 1. The diurnal distribution of vertebrate foraging at the flowers of an Umbrella Tree *Schefflera actinophylla* presented as the proportion of scans at which foraging vertebrates were present. The number of scans is eight at all times except 0700, 1600 and 1700 hours with 6 scans each, 0800 hours with 7 scans and 1200 and 1800 hours with 9 scans each.

Table 1. Vertebrates recorded feeding at the flowers of an Umbrella Tree *Schefflera actinophylla* during 99 daylight observations. The mean number of individuals is calculated for only those observations at which the species was present, to give an indication of group size.

	No. of observations	Mean no. individuals
Parrots		
Rainbow Lorikeet <i>Trichoglossus haematodus</i>	32	3.7
Honeyeaters		
Helmeted Friarbird <i>Philemon buceroides</i>	21	2.4
Little Friarbird <i>Philemon citreogularis</i>	17	1.9
Blue-faced Honeyeater <i>Entomyzon cyanotis</i>	2	2.0
White-gaped Honeyeater <i>Lichenostomus unicolor</i>	39	5.3
Brown Honeyeater <i>Lichmera indistincta</i>	22	1.8
Rufous-banded Honeyeater <i>Conopophila albogularis</i>	13	1.4
Dusky Honeyeater <i>Myzomela obscura</i>	9	1.1
Flying foxes		
Black Flying Fox <i>Pteropus alecto</i>	2	1.0

Foraging by honeyeaters consisted of rapid probing of flowers as if obtaining nectar, whereas that of the Rainbow Lorikeets and the Black Flying Fox was slow and methodical and I could not rule out pollen feeding as the main activity. Unfortunately, the inflorescences were inaccessible and could thus not be examined closely.

During the *vertebrate activity period*, average attendance at the Umbrella Tree at any instant was four species and 11 individuals. The aggregation of birds was commonly such that a small movement by one caused the displacement of another, and a size-based hierarchy was evident in which the smaller honeyeaters were almost constantly flying from inflorescence to inflorescence or to adjacent perches apparently awaiting foraging opportunities. The behaviour of the abundant White-gaped Honeyeaters in particular suggested *ad hoc* aggregation at a concentrated food source rather than any coordinated flocking behaviour. The sole vertebrate observation at the flowers outside the *vertebrate activity period* was of a single White-gaped Honeyeater feeding at 0900 hours.

Figure 1 suggests a distributional tail of activity at 1400 hours and perhaps also again at 1900 hours. On three days, four species of birds (a Rainbow Lorikeet and a Little Friarbird, one White-gaped Honeyeater and one Rufous-banded Honeyeater respec-

tively) were observed at 1400 hours to be sitting on the inflorescences but not feeding, a behaviour noted outside the *vertebrate activity period* on only two occasions.

I observed large invertebrates - butterflies or moths - at the flowers on only three occasions, once at 0900 hours and twice at 1200 hours. In each case there was only one individual involved. Because of the distance, I could not confirm that they were feeding nor identify the species.

In 17 nocturnal recording periods, there was no evidence of use of the Umbrella Tree flowers. That Black Flying Foxes were in the general area and therefore potentially able to make use of the blossom is indicated by the four daytime and three incidental nocturnal observations, well-spaced through the study period. I believe I would have detected groups of flying foxes because they interact noisily at nocturnal foraging sites, but could easily have missed solitary individuals.

Discussion

The timing of visits to flowers by animals can be influenced both by the timing of nectar secretion and by the activities and other priorities of the fauna involved. The remarkably consistent afternoon foraging by birds observed in this study, with activity commencing in the heat of the afternoon at c. 1400 hours and continuing for about five hours until close to sunset, runs counter to the general observation that bird activity is greatest (especially in hot climates) in the morning and secondarily in the late afternoon. The pattern of afternoon activity observed in this study is consistent with previous observations at this tree and opportunistic observations at other cultivated and one wild specimen (Franklin 1998 and unpubl. obs.). Brice Wells (pers. obs.) also noted that bird activity at a cultivated specimen in his Wanguri (Darwin) garden was consistently concentrated in the afternoon. These observations strongly suggest that bird activity at the flowers of Umbrella Tree is structured by the onset of nectar secretion in the early afternoon.

No foraging activity was identified after sunset, and although some such activity could have occurred undetected, clearly the flowers did not attract aggregations of flying foxes in the way that they had attracted aggregations of honeyeaters and lorikeets prior to sunset.

It seems, therefore, that the "strategy" of the Umbrella Tree is to attract birds as pollinators. Why then commence nectar secretion in the early afternoon when bird activity is normally at its lowest? Flowers of the hummingbird-pollinated iris *Rigidella flammea* open in the late afternoon (Cruden 1971), an even more unusual pattern. Cruden *et al.* (1983) suggested that aberrant diurnal patterns of flower-opening and/or nectar secretion could be an adaptation to avoid competition with other plant species for pollinators. This seems a plausible hypothesis for the evidently unusual pollination

biology of the Umbrella Tree, and one worthy of further investigation, ideally in the tree's natural rainforest habitat.

Acknowledgements

Richard Noske and John Woinarski commented helpfully on earlier drafts.

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Aerial survey of vertebrates in the Mann River district, central Arnhem Land

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Abstract

An aerial survey of large vertebrate fauna was undertaken in the Mann River district of central Arnhem Land in September 2000. The survey covered 3936 km² of the eastern and central part of the Arnhem Plateau and 1944 km² on the adjacent lowland. A total of 747 individual animals from eight species were observed during the survey. Of these, four species were native (antelope wallaroo, black wallaroo, emu and euro) and four were feral (buffalo, cattle, horse and pig). The majority of sightings (92%) were of feral animals, of which 78% were buffalo. The distribution of feral animals was largely similar to that of previous surveys with a high concentration in the upper Mann River and McCaw Creek regions. Sightings of native species were scattered throughout the survey area. The uncorrected density estimates (km⁻² ± SE) for species observed in this aerial survey were: buffalo 0.74 ± 0.08; cattle 0.10 ± 0.04; horse 0.009 ± 0.008; pig 0.007 ± 0.003; black wallaroo 0.02 ± 0.006; and emu 0.006 ± 0.003.

Introduction

Arnhem Land is a large area of Northern Australia that is owned and managed by Aboriginal people. Arnhem Land covers over 95,000 km² in the north-east of the Northern Territory and encompasses an array of habitats from coastal and inland water systems, to monsoon forest, open woodland and the escarpment of the Arnhem Plateau (Cole 1978). The area is home to a large number of feral animals such as buffalo (*Bubalus bubalis*), cattle (*Bos taurus*), horses (*Equus caballus*) and pigs (*Sus scrofa*) that were introduced to the Northern Territory in the late 1800's (Chaloupka 1982). While some feral animals are utilised as a food resource by Aboriginal communities (Altman 1987), they can also cause significant environmental damage and are a potential disease threat when densities are high (Bayliss and Yeomans 1989a). The continued monitoring of feral vertebrate populations in Arnhem Land is important to ensure that densities are maintained at appropriate levels.

Aerial surveys provide the means by which large vertebrate populations can be monitored over great area and in remote locations (Clancy 1999). The vertebrate fauna of central Arnhem Land has previously been surveyed by light aircraft on two occasions in the past two decades (Bayliss and Yeomans 1989a, Saalfeld 1998), and these surveys have shown significant but decreasing numbers of feral animals over a thirteen-year period.

This report provides information on the distribution, density and population size of feral animals (buffalo, pigs, horses, and cattle) in the northern section of the Arnhem Land plateau and adjacent lowland areas northwest of the plateau. The current survey was not intended to replicate previous broad-scale surveys, but rather attempted to provide information on the range and distribution of emu (*Dromaeus novaehollandiae*) and macropod species. However, it became evident early in the survey that the technique was not precise enough for this purpose and the focus of the survey switched to feral animals, in particular feral buffalo. Nevertheless, some information for emu, black wallaroo *Macropus bernardus* and antilopine wallaroo *Macropus antilopinus* is included here.

Methods

Aerial survey

An aerial survey was carried out between 7-11th September 2000 in central Arnhem Land by members of the Key Centre for Tropical Wildlife Management (Tony Griffiths and Jennifer Koenig) and the Djelk Rangers (Charles Godjuwa, Otto Campion and Dean Yibarbuk). The survey was based at Margalwo outstation on the Arnhem Plateau (12° 50.1'S, 133° 55.1'E), approximately 100 km southeast of Maningrida township. The survey area (5880 km²) is composed of two distinct habitat types, plateau (3936 km²) and lowland (1944 km²). The plateau is characterised by rugged sandstone outcrop with low open rocky woodland while the lowland is primarily floodplains and tall open forest on deep sandy soils.

The survey area was systematically sampled by east-west transects placed 2.8 km apart on the plateau and 3.7 km apart on the lowland survey (Fig. 1). A total of 39 transects, each 54 km long, were flown giving a sampling intensity of 18.5% (626 km²) on the plateau and 12.2% (237 km²) on the lowland survey. A Cessna 185 fitted with a radar altimeter and global positioning system was used for the survey. The aircraft was flown at an altitude of 200 ft (61 m) above ground level at a ground velocity of 100 knots (185 kmh⁻¹). The transect width of 200 m each side of the aircraft path was delineated using fibreglass rods attached to the wing struts. The transect width was calibrated by flying at 61 m over two forty-four gallon drums placed 200 m apart on the runway.

There were two observers (port and starboard) in the rear of the plane, while a third person (seated front starboard) acted as recorder. For a sub-sample of transects, the recorder acted as a third observer. The position and time of each observation was recorded using a Hewlett Packard HP200LX palmtop computer programmed as a datalogger and linked to a GPS. For each observation the following information was recorded: species; number of animals per group; habitat in which the group (or individual) was seen; and observer. Habitats were grouped into four broad categories: open woodland (moderate canopy cover and height); wet woodland (wetland and riparian habitats); rocky woodland (low and sparse canopy); and sandsheet forest (tall forest dominated by *Eucalyptus tetrodonta*).

Data analysis

Density and population estimates were calculated for each species using the ratio method (Caughley 1979). Correction factors were not calculated for this survey as double counts were only gathered for a small sub-sample of transects. However, we have included results based on the correction factors from a previous aerial survey of Arnhem Land (Bayliss and Yeomans 1989b). These factors correct for observer bias in the open woodland and are applied here to provide a more accurate approximation of the actual number of buffalo, cattle and horses present.

Students t-tests were used to compare the density of each species (with ten or more sightings) in plateau and lowland areas. Students t-tests were also used to compare animal sightings between the port and starboard side of the plane. A contingency table analysis was used to test whether species differed in the proportion of animals observed in each of the major habitat types. We also tested for difference in buffalo abundance across habitat types using a one-way ANOVA, using the raw group size data. For all buffalo sightings, we calculated the distance to the nearest drainage line using ArcView 3.2a.

Results

Distribution, density and population estimates

A total of 747 individual animals from 8 species were sighted during the aerial survey. Of the 8 species observed, 4 were native (emu, antilopine wallaroo, black wallaroo and euro) and 4 were exotic (buffalo, cattle, horse, pig). The sightings, number of individuals and mean group sizes for each species are presented in Table 1. The majority of sightings were for feral animals (92%), with buffalo accounting for 78% of sightings.

Figures 2 and 3 show the distribution of sightings for each species. Although buffalo were widely distributed throughout the survey area, most were concentrated on the

Table 1. Summary of sightings, individual counts and mean group size estimates (\pm one standard error) for wildlife species recorded during the aerial survey.

	<i>Sightings</i>	<i>Individuals</i>	<i>Mean group size</i>
Buffalo	185	623	3.4 \pm 0.27
Cattle	24	88	3.7 \pm 0.9
Horse	2	8	4 \pm 3
Pig	6	6	1 \pm 0
Antilopine Wallaroo	1	2	2
Black Wallaroo	12	14	1.2 \pm 0.11
Emu	4	5	1.3 \pm 0.25
Euro	1	1	1

eastern side of both the plateau and lowland survey blocks, and in particular around the McCaw Creek and Mann River regions in the southeast. Feral cattle had a more patchy distribution and horses were confined to the southeast of the survey. In contrast, sightings of the black wallaroo were concentrated in the northwest region of the plateau, west of Margalwo outstation. The small number of sightings of the other native and feral species were scattered throughout the survey area (Fig. 3).

The uncorrected density estimates for each species are presented in Table 2, calculated for the entire survey area and separately for the plateau and lowland. There were no significant differences in density between the plateau and lowland areas for buffalo ($t = 0.93$, $p = 0.35$), black wallaroos ($t = 0.89$, $p = 0.38$) or cattle ($t = 1.79$, $p = 0.082$).

The uncorrected population estimates calculated for each species sighted in the survey are presented in Table 3. Due to the low number of sightings the precision (measured by the SE) of the estimate is poor for all species except buffalo. Corrected estimates for buffalo, cattle and horses are presented in Table 4.

Habitat variables

Contingency table analysis showed that the proportion of animals in each major habitat type differed significantly between species ($\chi^2 = 85.41$, $p < 0.001$). These results reflect two distinct patterns, with feral animals (buffalo, cattle, horse and pig) sighted more often in the open and wet woodland and native species (black wallaroo and emu) more often in the rocky woodland (Table 5).

The size of each buffalo group was significantly related to the habitat in which the group was seen ($F = 2.93$, $p = 0.03$). The mean group size (\pm one standard error) of

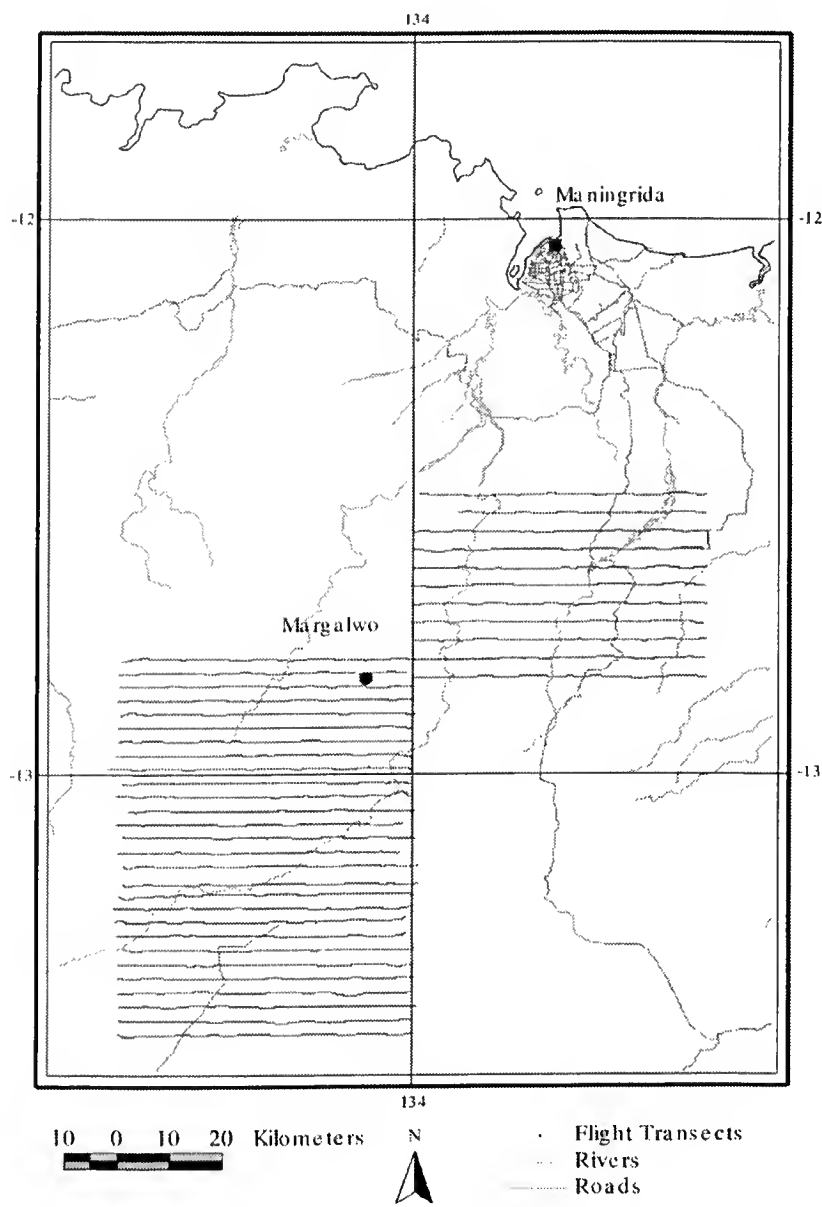


Figure 1. Location of aerial survey flight transects.

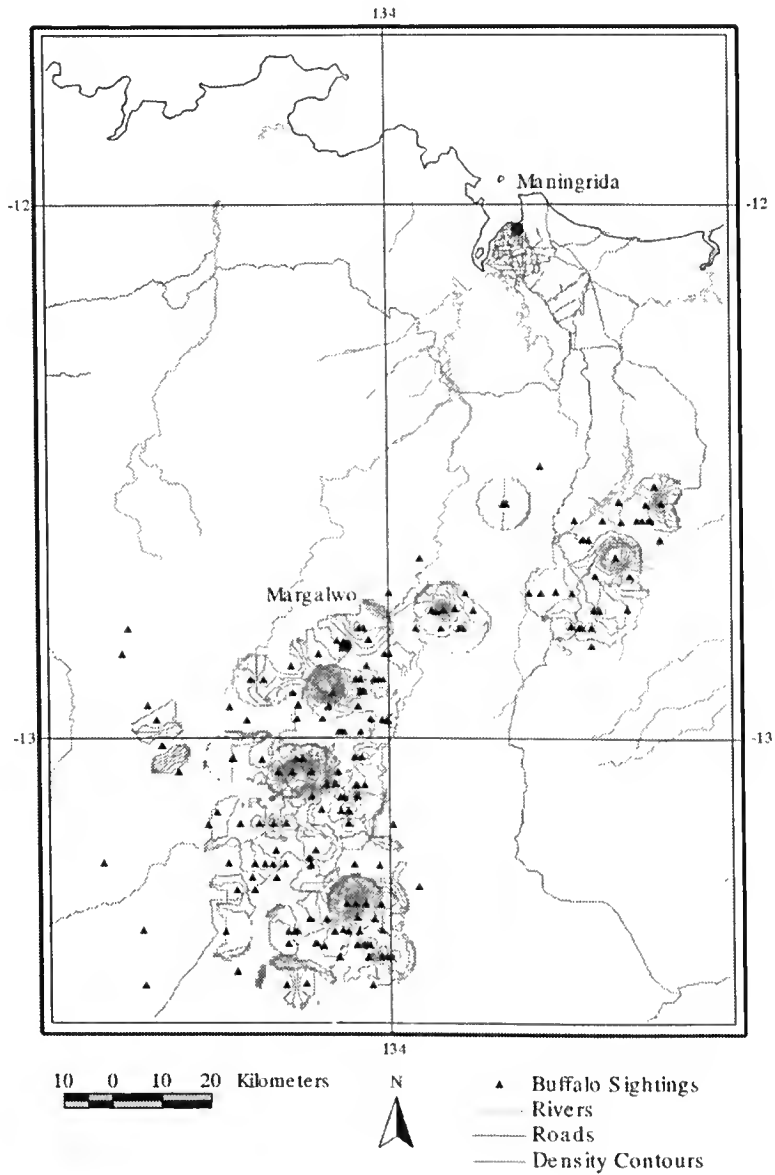


Figure 2. Distribution and density patterns of buffalo sighted in the aerial survey. Density contours have a base of 1 and an interval of 1.

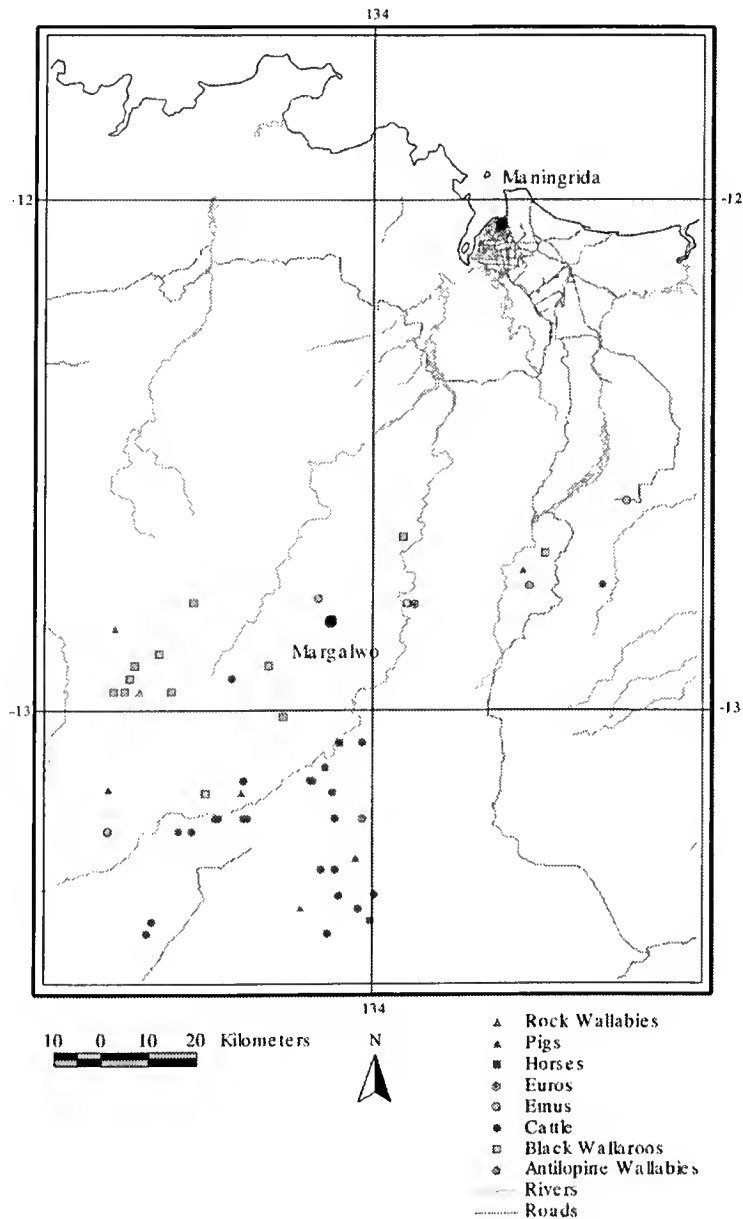


Figure 3. Distribution of all species (except buffalo) sighted in the aerial survey.

Table 2. Uncorrected density estimates (animals per km² \pm one standard error) for wildlife species recorded during the aerial survey. Estimates were calculated for the entire survey area and separately for the two topographic regions (plateau and lowland).

	<i>Total</i> (5880 km ²)	<i>Plateau</i> (3936 km ²)	<i>Lowland</i> (1944 km ²)
Buffalo	0.74 \pm 0.08	0.79 \pm 0.09	0.61 \pm 0.18
Cattle	0.10 \pm 0.04	0.14 \pm 0.05	0.004 \pm 0.004
Horse	0.009 \pm 0.008	0.013 \pm 0.011	0
Pig	0.007 \pm 0.003	0.008 \pm 0.004	0.004 \pm 0.004
Black Wallaroo	0.02 \pm 0.006	0.02 \pm 0.008	0.008 \pm 0.006
Emu	0.006 \pm 0.003	0.002 \pm 0.002	0.02 \pm 0.009

Table 3. Uncorrected population estimates (\pm one standard error) of wildlife species recorded during the aerial survey, September, 2000. Estimates were calculated for the entire survey area and separately for the two topographic regions. Values in parentheses are the standard error as a proportion of the estimate.

	<i>Total</i> (5880 km ²)	<i>Plateau</i> (3936 km ²)	<i>Lowland</i> (1944 km ²)
Buffalo	4349 \pm 492 (0.11)	3105 \pm 366 (0.12)	1195 \pm 352 (0.29)
Cattle	614 \pm 213 (0.35)	566 \pm 191 (0.34)	8 \pm 8 (1)
Horse	56 \pm 49 (0.88)	52 \pm 46 (0.88)	0
Pig	42 \pm 19 (0.45)	33 \pm 16 (0.48)	8 \pm 8 (1)
Black Wallaroo	98 \pm 34 (0.35)	78 \pm 30 (0.38)	16 \pm 11 (0.69)

Table 4. Corrected density and population estimates (\pm one standard error) of buffalo, cattle and horse observed during the aerial survey. The correction factors are those of Bayliss and Yeomans (1989b) for the open woodland habitat.

	<i>Total</i> (5880 km ²)	<i>Plateau</i> (3936 km ²)	<i>Lowland</i> (1944 km ²)
Buffalo	4349 \pm 492 (0.11)	3105 \pm 366 (0.12)	1195 \pm 352 (0.29)
Cattle	614 \pm 213 (0.35)	566 \pm 191 (0.34)	8 \pm 8 (1)
Horse	56 \pm 49 (0.88)	52 \pm 46 (0.88)	0
Pig	42 \pm 19 (0.45)	33 \pm 16 (0.48)	8 \pm 8 (1)
Black Wallaroo	98 \pm 34 (0.35)	78 \pm 30 (0.38)	16 \pm 11 (0.69)

buffalo in open woodland, wet woodland, sand-sheet forest and rocky woodland was respectively: 3.13 ± 0.49 ; 4.43 ± 0.51 ; 2.54 ± 0.37 and 2.37 ± 0.60 . Over 80% of all buffalo sightings were within 400 m of a drainage line (Fig. 4).

Observer bias

The mean number of animal groups sighted per transect was 3.72 for the starboard side of the plane compared to 2.08 for the port side ($t = 2.87$, $p = 0.005$). Similarly, the mean number of individual animals counted per transect was significantly higher on the starboard side (10.72 *vs* 5.54 ; $t = 3.08$, $p = 0.003$). The observers on the port

Table 5. The number of sightings for each species in each of the four habitat types, as a percentage of the total number of sightings (in parentheses) .

	<i>Open woodland</i>	<i>Wet woodland</i>	<i>Sandsheet forest</i>	<i>Rocky woodland</i>
Buffalo (185)	38	33	19	10
Cattle (24)	70	17	4	9
Pig (6)	33	50	0	17
Black Wallaroo (12)	0	0	8	92
Emu (4)	0	0	25	75

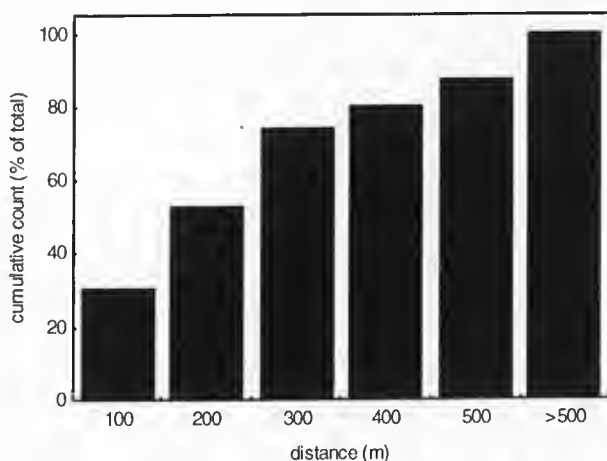


Figure 4. Distance of buffalo sightings to the nearest drainage line.

and starboard side of the plane remained consistent for 31 out of the 39 transects. Analyses of the most commonly sighted species (buffalo) for these 31 transects revealed a similar pattern to that described above for all animal sightings.

Discussion

Distribution, density and population estimates

Feral buffalo were widespread throughout the entire survey area (Fig. 2) with particularly high concentrations around the McCaw Creek and Mann River region in the east of the plateau survey area. In contrast, feral horses, pigs and cattle were patchily distributed, with concentrations in the Bulman Gorge and upper Mann River area at the southern end of the survey area (Fig. 3). This area has been identified in previous aerial surveys as having a relatively high density of feral animals (Saalfeld 1998, Bayliss and Yeomans 1989a).

The uncorrected buffalo density estimates from this study are higher than those reported in the last extensive aerial survey of Arnhem Land in 1998 (Saalfeld 1998). However, buffalo density from the 1998 survey for the same area was 0.85 km^{-2} (K. Saalfeld, pers. comm.). This suggests a relatively stable buffalo numbers over the two years between these surveys. Buffalo densities reported for this area from an aerial survey in 1985 (Bayliss and Yeomans 1989a) were higher than the results from the present survey. The apparent decrease in buffalo numbers over the 15 year period may be due to the BTEC (Brucellosis and Tuberculosis Eradication Control) program, which operated in Arnhem Land between 1985 and 1995 (Ridpath and Waithman 1988, Saalfeld 1998). Alternatively, mustering may have reduced numbers, particularly in the southern part of the survey area. The density estimates for feral cattle are also similar to those reported by the 1998 Arnhem Land feral animal survey (Saalfeld 1998). In contrast, density estimates for horse are much lower in the present survey, but our survey did not encompass the areas of high horse density sampled by Saalfeld (1998).

A factor that may influence the results of aerial survey is the choice of sampling platform. There are particular advantages and disadvantages associated with each sampling platform (helicopter versus fixed-wing aircraft) and these will determine the method used in a particular survey. A helicopter is able to travel slower and at lower heights than a fixed-wing aircraft allowing for easier species observation and identification (Clancy 1999). However, the cost of a helicopter survey is considerably greater, the duration of each flight shorter and consequently the survey area is much smaller than if using a fixed-wing aircraft (Clancy 1999). For this survey we used a fixed wing aircraft in order to cover a large area of central Arnhem Land. While the use of this sampling platform enabled us to effectively sample the larger vertebrates (buffalo and cattle) it compromised our ability to detect the smaller native animals. A recent heli-

copter survey of a small section of Arnhem Land (covering part of the lowland area sampled in this survey) recorded a much higher density of large macropods (9.3 km^{-2}) and emu (0.3 km^{-2} ; Yibarbuk *et al.* 2001) than was detected with the present fixed-wing aircraft survey.

Estimates of density and population from aerial surveys are negatively biased and represent only a proportion of the actual population (Bayliss and Yeomans 1989b). The use of correction factors is a method of accounting for this negative bias (Cairns 1999). Ideally, survey specific correction factors should be obtained by using a combination of the double count methodology (Marsh and Sinclair 1989; Bayliss and Yeomans 1989b) and ground survey techniques. The correction factors of Bayliss and Yeomans (1989b) used in this report are a combination of both observer and environmental bias and should be used with caution when applied to other surveys. Thus, while the corrected density and population estimates for buffalo, horses and cattle (Table 4) provide a more accurate approximation than the uncorrected values, they are unlikely to be entirely accurate.

Habitat variables

We found that the mean group size for buffalo was significantly different between the major habitat types. Previous surveys have demonstrated a negative relationship between visibility of buffalo and canopy cover, and have derived correction factors for each habitat based on mean group size (Bayliss and Yeomans 1989b). Thus, our results may reflect a group visibility bias in relation to habitat type. Alternatively, some habitats may be more favourable to buffalo and support larger group sizes. The presence of water seems to be one factor influencing the distribution of buffalo, with over 80% of all buffalo sighted within 400 m of a drainage line. Similarly, previous surveys have noted that wetland and *Eucalyptus* woodland endowed with fresh water (rivers, creeks, springs and billabongs) were areas of high buffalo density (Bayliss and Yeomans 1989a).

Observer bias

This survey served, in part, as an educational exercise in aerial survey techniques for members of the Key Centre for Tropical Wildlife Management and the Djelk Aboriginal Rangers. The participants of this aerial survey had minimal experience in observing and counting animals from the air. It is recommended that observers have a minimum air training time of 100 hours before being included in the collection of data (Bayliss and Yeomans 1989a; Beard 1999). The reasons for training include learning to work and concentrate in a confined and stuffy space for long periods; learning to work in turbulent conditions without feeling ill, and the need to develop a search image for each species from the air (Beard 1999). The use of inexperienced observers in this survey undoubtedly accounted for some inaccuracies in the data.

Recommendations and conclusions

The original aim of this study was to survey for emu and macropods. However, we were not able to accurately detect these species from a fixed-wing aircraft. For future surveys a helicopter may be a better alternative as they provide greater visibility and accuracy when surveying native animals (Clancy 1999; Pople *et al.* 1998). In order to obtain more accurate aerial survey data and to decrease habitat and observer bias we also recommend incorporating double-count techniques, habitat specific correction factors and ground-truthing into future aerial surveys (Bayliss and Yeomans 1989b; Clancy *et al.* 1997).

The feral animals in Arnhem Land are a valued resource to the Aboriginal owners. Large feral animals such as buffalo, cattle and pig provide an important food resource (Altman 1982, Altman 1987, Vardon *et al.* 1996), and commercial income is obtained from buffalo through "safari" tourism and periodic mustering (Johnson 2000). However, feral animals can cause significant environmental damage and are a potential disease threat (Bayliss and Yeomans 1989a, Ridpath and Waithman 1988). In order to manage feral animal populations to the benefit of local landowners, the distribution and density of feral species needs to be closely monitored. The use of aerial surveys provides the cost effective means of achieving this goal.

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Records of northern waterbirds in the Barkly wetlands, Northern Territory, 1993-2002

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Abstract

Nine species of waterbirds that principally occur in seaward-draining catchments of the Northern Territory were recorded in endorheic catchments of the Barkly Tableland, Mitchell Grass Downs bioregion, following major floods in 1993 and 2001. The migratory Garganey *Anas querquedula*, Swinhoe's Snipe *Gallinago megala* and Oriental Reed-Warbler *Acrocephalus orientalis* were observed in small numbers and White-winged Black Tern *Chlidonias leucopterus* in moderate numbers. Green Pygmy-goose *Nettion pulchellus*, Pied Heron *Ardea picata* and Black-necked Stork *Ephippiorhynchus asiaticus* were recorded in small numbers and Wandering Whistling-Duck *Dendrocygna arcuata* and Cattle Egret *Ardea ibis* in moderate numbers. Black-necked Stork probably bred in at least one wetland, a vast Coolibah swamp. Some of the nine species may have been colonists at these inland wetlands and their possible breeding status should be monitored in future surveys, others were most likely vagrants.

Introduction

During 1991-5 and 2000-2, temporary wetlands of the Barkly Tableland - the 'Barkly wetlands' - in the Mitchell Grass Downs bioregion (Environment Australia 2002a) were extensively inundated. The largest floods were early in 1993 (Jaensch 1994) and 2001. The principal wetlands, Tarrabool Lake, Lake Woods and Lake Sylvester, provided vast areas of open lake, wooded swamp, shrub swamp, grass/forb swamp and bare muddy shores as waterbird habitat.

The author and associates conducted 10 surveys of the Barkly wetlands on ground, by boat and/or by helicopter during 1993-2002: five in 1993; two in 1994; three in 1995; one in 2001; and one in 2002 (Jaensch 1994, Jaensch & Bellchambers 1997, R. Jaensch unpublished data). As a result, records of several waterbird species were obtained for the first time from the Barkly wetlands or added substantially to knowledge on occurrence, habitat use and/or breeding (Jaensch 2002a, b). This paper summarises the records of waterbird species that normally occur in seaward-draining, northern catchments of the Northern Territory.

Wandering Whistling-Duck *Dendrocygna arcuata*

Storr (1977) and Blakers *et al.* (1984) provide no records of Wandering Whistling-Duck from the Barkly wetlands. However, this waterbird is highly dispersive with vagrants reaching south-western and south-eastern Australia from the far north and east of Australia (Marchant & Higgins 1990).

There are six records of Wandering Whistling-Duck from the Barkly wetlands in the fauna database of the Parks & Wildlife Commission of the Northern Territory (A. Fisher pers. comm., August 2002) for the period 1982-91; another 13 records were obtained during 1993-2002. Most (15) of the records are from the Wet season (December-April). The species was recorded from more wetlands, and in larger numbers, in 2001-2 than in 1993-5 despite far fewer surveys. The highest counts from each major wetland are listed in Table 1 the location of major wetlands is shown in Fig. 1).

Where recorded in inundated woodland of Coolibah (presumed to be Barkly Coolibah *Eucalyptus barklyensis*) or Cooba *Acacia stenophylla*, the Wandering-Whistling-Ducks were not closely associated with other ducks. At beach, spit or bank roosting sites they were always associated with large numbers (up to 8000) of Plumed Whistling-Duck. It is conceivable that mixed flocks of these species travelled to the Barkly wetlands from northern parts of the Territory.

The records show that Wandering-Whistling-Duck is a regular visitor to the Barkly wetlands. All of the high counts occurred when the wetlands were full or with more than 10 000 ha of water.

Table 1. Highest counts of Wandering Whistling-Duck, Barkly wetlands, 1993-2002. 'Eva Downs Swamp' is an unnamed wetland at the terminus of Cherub Creek..

Wetland (sector)	Habitat	Date	Count
Corella Lake (N)	Sand & gravel beach/chenier	6 Jun 2001	960
Lake de Burgh (N)	Muddy spit on drying shore	17 Dec 1993	415
Lake Sylvester (E)	Delta channels of Brunette Creek	13 Apr 2002	200
Tarrabool Lake (N)	Sand & gravel beach/chenier	29 Mar 1994	46
Lake Woods (W)	Coolibah wooded swamp	10 Apr 2002	40
Eva Downs Swamp	Cooba wooded swamp	6 Jun 2001	40

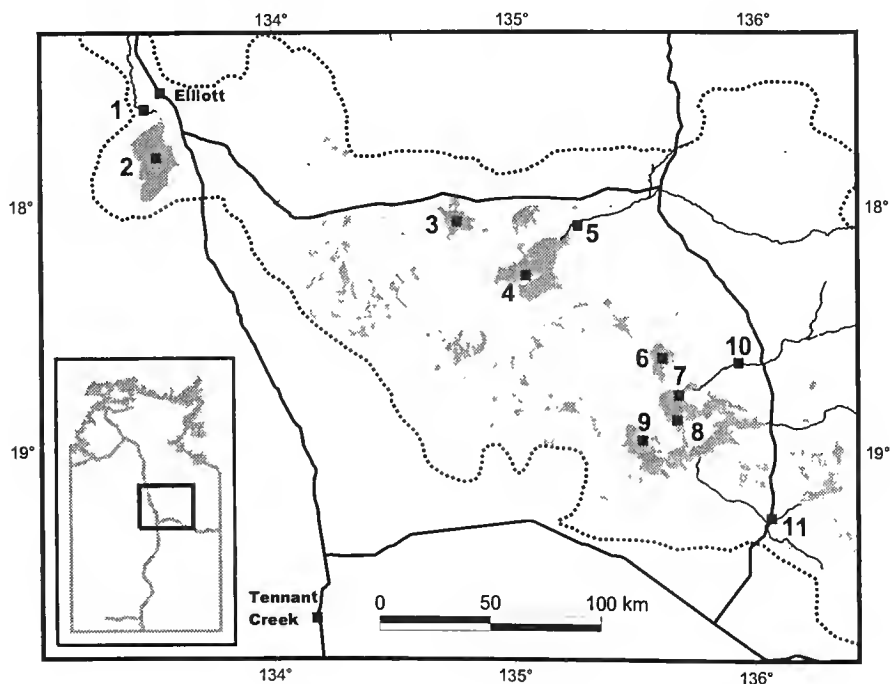


Figure 1. Locations on the Barkly Tableland mentioned in the text: 1, Longreach Waterhole; 2, Lake Woods; 3, Eva Downs Swamp; 4, Tarrabool Lake; 5, Cresswell Ck; 6, Corella Lake; 7, Big Hole waterhole; 8, Lake Sylvester; 9, Lake de Burgh; 10, Brunette Downs homestead; 11, Upper Amazon lagoon. Shaded areas are subject to periodic inundation, although some lakes (particularly the Tarrabool and Sylvester complexes) may become larger than shown here. The boundary of the Mitchell Grass Downs bioregion is shown by the dotted line.

Green Pygmy-goose *Nettapus pulchellus*

Before the 1993–2002 surveys, only one record of Green Pygmy-goose in the Mitchell Grass Downs had been published (Blakers *et al.* 1984) and an undated record west of Tennant Creek (Storr 1977, Marchant & Higgins 1990, PWCNT fauna database) was the only other Northern Territory record outside the seaward-draining catchments.

On 24 September 1993, a pair of Green Pygmy-goose was observed in the north-western, wooded part of Lake de Burgh (18° 53.1' S, 135° 29.9' E). Water was 0.3–0.5 m deep and devoid of aquatic plants on the surface. At the time, the receding lake still covered more than 15 000 ha. The pygmy-geese were identified by their dark green or

black backs, upper-wing coverts and primaries, which contrasted strongly with their white secondaries. In size they were smaller than the Grey Teal *Anas gracilis* present and their wing-beats were fast and shallow.

The two pygmy-geese were probably vagrants. Long-distance dispersal of this northern waterbird sometimes occurs and there are records from south-western and south-eastern Australia (Marchant & Higgins 1990).

Garganey *Anas querquedula*

On 18 May 1993, a male Garganey in full breeding plumage was observed in the northern part of Lake Woods (17° 44.4' S, 133° 31.3' E), in a swampy zone more than 1 km wide. The swamp contained shrubs of lignum *Muehlenbeckia florulenta* to 2 m height in water up to 1 m deep, among which the aquatic creeper *Ipomoea ?diamantiniensis* grew prolifically, as well as dense thickets of budda pea *Aeschynomene indica* to 3 m in water about 0.5 m deep. This community lay between extensive Coolibah woodland and open lake.

The Garganey was seen in flight at a height of about 20 m; its flight was rapid, at least as fast as that of Hardhead *Aythya australis* with which it flew, and its light grey upper-wing coverts were conspicuous. It was about half the size of a Hardhead and its brown head and chest were in strong contrast to its pale eye-stripe and white central belly.

Individuals or small groups of Garganey, a migrant from Asia, occur in wetlands of the Darwin Coastal bioregion (Environment Australia 2002a), and are reported mainly in the late Dry season and early Wet season (Marchant & Higgins 1990, PWCNT fauna database, R. Jaensch pers. obs.). The Lake Woods bird was undoubtedly a vagrant. A record from Alice Springs in December 1978 (Marchant & Higgins 1990) is the only previous, published record of Garganey from inland Northern Territory. Garganey occasionally travel much farther south, reaching south-western and south-eastern Australia (Storr 1977, Blakers *et al.* 1984). The species is listed as 'Data Deficient' under Northern Territory legislation.

Pied Heron *Ardea picata*

Apart from records in October-November 1993 from the Alice Springs area and unconfirmed records from the Tanami and Great Sandy Deserts, the Pied Heron is not normally recorded outside seaward-draining catchments in the Northern Territory (Storr 1977, Blakers *et al.* 1984, Marchant & Higgins 1990, PWCNT fauna database). Vagrants occasionally reach south-eastern Australia.

Records of Pied Herons in the Barkly wetlands in 1993, 2001 and 2002 are listed in chronological order in Table 2. The 1993 birds were all adults, with a blue-black cap

Table 2. Records of Pied Heron from the Barkly wetlands, 1993-2002.

<i>Wetland (sector)</i>	<i>Habitat</i>	<i>Date</i>	<i>Count</i>
Lake Woods (NE)	Shallow open water & shore	22 Sept 1993	1
Lake de Burgh (N)	Muddy open shore	17 Dec 1993	2
Lake Woods (N) and Longreach Waterhole	Coolibah wooded swamp; inundated mixed woodland fringing the waterhole	30 May 2001, 7 Jun 2001	16
Eva Downs Swamp	Cooba wooded swamp	6 Jun 2001	1
Big Hole waterhole	Inundated mixed woodland fringing the waterhole	6 Jun 2001	8
Big Hole waterhole	Bare gravel beach near end of waterhole	12 Apr 2002	6
Lake de Burgh (N)	Coolibah wooded swamp with mats of aquatic weed	13 Apr 2002	1

and yellow legs. The Pied Herons at Lake de Burgh were discovered in a roost of 8 400 whistling-ducks on a marshy spit and five of the larger White-necked Heron *A. pacifica*, which has no black cap and has grey legs, were nearby for comparison.

Many of the 16 birds observed at Longreach Waterhole in June 2001 were immature, lacking black caps. Some birds at Lake Woods and Eva Downs Swamp in June 2001 were associated with colonies of nesting Great Egret *A. alba* in Cooba wooded swamp. Although no nesting by Pied Heron was confirmed, presence in the colonies and occurrence of immatures lends some support to the possibility that this species bred in the Barkly wetlands in 2001. It remains to be seen if the species establishes a long-term presence in these wetlands as a result of the 1993 and 2001 floods.

Pied Herons were recorded well south and inland of their normal range in eastern Australia during 2000 and 2001, with small groups observed in the Channel Country bioregion (Environment Australia 2002a) following major floods (J. Reid & R. Jaensch unpublished data) and in the Macquarie Marshes, New South Wales (Eades 2001).

Cattle Egret *Ardea ibis*

Cattle Egrets occur and breed in large numbers in the Darwin Coastal bioregion (Storr 1977, Chatto 2000), and vagrants have been reported in the Alice Springs area (Blakers *et al.* 1984, Marchant & Higgins 1990, PWCNT fauna database).

One or two birds were seen at Lake Woods and Lake de Burgh in 1993. More signifi-

cantly, substantial flocks were seen at two Barkly wetlands in the period 10-14 April 2002: 60 and 100 near the south-west side of Lake Woods, and 65 and 70 near the north side of Corella Lake and at nearby Edwards Creek respectively. All of the egrets seen in 2002 were feeding in association with cattle in Annual Verbine *Cullen cinereum* and other meadow vegetation on lake bed that had been inundated in 2001 but that had been dry for many months.

Cattle Egret continues to expand its range in Australia and it is highly likely that the species will establish a long-term presence in the Barkly wetlands and associated meadows, possibly influenced by the 2001 flood.

Black-necked Stork *Ephippiorhynchus asiaticus*

Casual occurrence of Black-necked Storks in the Northern Territory at least as far south as the Mitchell Grass Downs has been previously documented (Storr 1977, Blakers *et al.* 1984). At least 19 records of Black-necked Stork in the Barkly wetlands have been obtained over the past two decades (PWCNT fauna database, Jaensch & Belchambers 1997, R. Jaensch unpublished data). Storks were recorded at each of the major lakes (Woods, Tarrabool, Corella, Sylvester and de Burgh) and/or associated waterholes. The largest groups were: 12, most of them immature, at South Newcastle Bore (17° 40.6' S, 133° 32.6' E) near the northern limit of Lake Woods, on 10 April 2002; five, all immature, at a small pond near Lake Sylvester on 13 April 2002; and five, at least two of them immature, at a waterhole (18° 13.9' S, 135° 5.0' E) in the channel of Cresswell Creek in the north-east of Tarrabool Lake, on 29 March 94. Immature birds had pale or dull-coloured head and neck and some grey-brown, rather than all black, marks on the white upper-wings.

The age at which adult plumage is attained by Black-necked Stork is not certain but it may take several years (Marchant & Higgins 1990). Thus, some or all of the free-flying immatures seen at the Barkly wetlands during 1993-2002 may have been raised elsewhere, in near-coastal areas, but travelled inland to the Barkly wetlands many months later. Stronger evidence that Black-necked Storks bred locally was obtained on 31 March 1993, when a stork was observed at a nest during an aerial transect survey over the south-western part of Tarrabool Lake. The brief view and survey procedure did not permit determination of nest contents or further investigation of the association between stork and nest. Habitat was extensive Coolibah wooded swamp with water that was at least 1 m deep.

It is possible that Black-necked Stork has established a small persistent population in the Barkly wetlands, aided by the wet periods in 1991-5 and 2000-2 during which local conditions - extensive wooded wetlands and abundant food supply - were probably suitable for breeding. The range of a number of Australian Ciconiiformes has expanded

during the 20th century (Serventy & Whittell 1976, Blakers *et al.* 1984, Marchant & Higgins 1990).

Swinhoe's Snipe *Gallinago megala*

In the Northern Territory, *Gallinago* snipe have been recorded mainly from the Darwin Coastal bioregion and adjacent areas, and exceptionally from the Alice Springs area (PWCNT fauna database). Most records of definite identity are of Swinhoe's Snipe but Pin-tailed Snipe *G. stenura* and Latham's Snipe *G. hardwickii* also occasionally occur (Higgins & Davies 1996).

On 14 December 1993, 26 *Gallinago* snipe were flushed from an area of about 1 ha in swamp on the drying north-eastern side of Lake Woods (17° 45.6' S, 133° 32.8' E). Habitat was open shrubland of Lignum to about 1.5 m height over extensive dense Nardoo *Marsilea* sp., or bare mud. Water depth varied from 0 to 0.3 m due to 'gilgai' hollows in the clay substrate. Similar habitat extended for hundreds of metres in a band around the lake.

On 16 December 1993, two *Gallinago* snipe were flushed from a cluster of mud and stone islets with tussocks of couch grass in the drying north-east part of Lake Sylvester (18° 45.3' S, 135° 38.9' E). Landward of the site was an extensive wet marsh of Rat's Tail Couch *Sporobolus mitchellii* that had been cropped short by cattle. Water was of uneven depth due to gilgai hollows but over several hectares was mostly less than 0.1 m deep. After landing 20 m away, the birds were observed closely through tripod-mounted spotting scopes.

On 4 January 1995, a single *Gallinago* snipe was observed squatting on mud beside a Lignum shrub, then flushed twice, in swamp associated with Two Mile Waterhole on Brunette Creek (18° 39.4' S, 135° 58.5' E). The swamp had dried back a little after recent brief inundation.

On 31 January 1995, a single *Gallinago* snipe was flushed and briefly pursued by helicopter, at South Newcastle Waterhole (17° 38.7' S, 133° 32.4' E). The tree-lined waterhole was almost dry at this point, with water confined to small shallow pools in its floor.

Field identification of *Gallinago* snipe, and separation of *G. megala*, *G. stenura* and *G. hardwickii* in particular, is difficult (Higgins & Davies 1996) and most field identifications without a bird in the hand therefore should be regarded as tentative. However, prior to the Barkly sightings, the author had obtained substantial field experience with each species in Australia - notably with *G. megala* near Darwin over preceding months in 1993 and 1995 - and/or overseas in situations where the identity of the birds had been established by capture or where the other species normally did not occur. Identification of most if not all of the Barkly snipe as *G. megala* was based on that experience

and the following characteristics (Higgins & Davies 1996, pp. 29-30): slight or negligible projection of the toes beyond the folded tip of tail when flying (hence not *G. stenura*); infrequent calling during escape flights (unlike the typically vocal *G. hardwickii*); short (less than 30 m) direct escape flights (unlike typical *G. hardwickii*); and no prominent white trailing edge to the upper-wing (ruling out Common Snipe *G. gallinago* of South-east Asia). Furthermore, the Lake Sylvester snipe (at rest) showed a noticeable protrusion of the tail and vent beyond the folded wing tip, probably longer than typical of *G. stenura* but not to the extent usually conspicuous in *G. hardwickii* (Higgins & Davies 1996).

Swinhoe's Snipe is currently listed as 'Data Deficient' under Northern Territory legislation. Further surveys, especially in the late Dry and early Wet seasons when wetland habitat is least widespread, may provide more information on the (perhaps frequent) occurrence of *Gallinago* snipe in the Barkly wetlands.

White-winged Black Tern *Chlidonias leucopterus*

The White-winged Black Tern is a regular migrant from Asia to the marine and coastal fresh-water wetlands of northern Australia, and to many wetlands in southern Australia, but is relatively uncommon inland in the arid zone (Blakers *et al.* 1984, Higgins & Davies 1996). Generally it is most abundant along the north coast.

Substantial numbers were recorded from several of the Barkly wetlands during 1993-2002: the highest counts are shown in Table 3. In April 2002, the White-winged Black Terns were often in tight flocks of around 100 birds, hawking over water and nearby

Table 3. Highest counts of White-winged Black Tern, Barkly wetlands, 1993-2002.

Wetland (sector)	Habitat	Date	Count
Lake Sylvester (E)	Open shallow water with aquatic weed mat, and adjacent grassland and forb meadows	12-14 Apr 2002	1222
Lake de Burgh (N)	Open shallow water with aquatic weed mat, and bare muddy shore	13 Apr 2002	455
Lake Woods (SW)	Lignum swamp, deeply inundated	11 Apr 2002	100
Upper Amazon Lagoon, Playford River	Open water of waterhole & muddy bare shore	1 Feb 1995	59
Corella Lake (N)	Open shallow water, with aquatic weed mat	13 Apr 2002	20

meadows, and many individuals displayed the diagnostic characters of adults in breeding plumage - fully black chest, head and upper back, in strong contrast to the white upper-wing coverts (Higgins & Davies 1996) - which enabled easy separation from the similar Whiskered Tern *C. hybridus*.

Irruptions of thousands of White-winged Black Terns occur from time to time in Australia, often in association with cyclones (Higgins & Davies 1996). Although large numbers were recorded in the Barkly wetlands in 2002, a similar result was not recorded in other years when lake habitat was extensive. The 22 records to date (PWCNT fauna database, R. Jaensch unpublished data) indicate that the species is a frequent visitor to the Barkly wetlands, mainly in the Wet season (all but 3 records), with infrequent occurrence of large numbers.

Oriental Reed-Warbler *Acrocephalus orientalis*

The Oriental Reed-Warbler (the relevant population was formerly known as Great Reed-Warbler *A. arundinaceus*) breeds in Asia and is infrequently recorded in Australia. There are several records from the Top End of the Northern Territory: from Melville Island, the Darwin area and the Fogg Dam area (McKean 1983, Blakers *et al.* 1984, PWCNT fauna database, R. Jaensch pers. obs.). Identification from Clamorous Reed-Warbler *A. stentoreus* in the field is difficult.

On 4 January 1995, the author heard a reed-warbler calling spasmodically in a shallowly inundated pile of dead *Parkinsonia aculeata*, and later in a live shrub of this woody weed, at a bore on the Barkly Stock Route south-east of Elliott (17° 43.8' S, 133° 42.3' E). The bore's 'turkey nest' dam was full and contained a stand of dense live Cumbungi *Typha* sp. and water lay in broad pools surrounding the dam. The bird remained hidden but its calls were short, with harsh phrases like those of *A. orientalis* rather than the more musical calls of *A. stentoreus*. The calls were consistent with calls of *A. orientalis* learnt by the author while resident in Malaysia during 1989-91 and sometimes heard during the Wet season at Fogg Dam (1993-5), but unlike the familiar calls of *A. stentoreus*. Three birds of another rare Asian migrant, the Barn Swallow *Hirundo rustica* (identified by their dark chest bands), were at this site at the same time; eight were also present on 30 January 1995.

On 5 January 1995, a reed-warbler was detected in thickets of oleander and bougainvillea shrubs in the gardens of Brunette Downs homestead (18° 38.50' S, 135° 56.6' E). First heard at 0730 h, the bird was still calling when revisited at 0900 h. Calls were varied, generally harsh and typical of *A. orientalis*; a brief, weak tape recording was made. The bird readily came closer in response to imitations of its calls and from distances of less than 10 m, thin brown streaks were obvious on the sides of the bird's chest and throat, a character of *A. orientalis* but not of *A. stentoreus* (Pizzey & Knight 1999). Other plumage and soft part characters were broadly similar to those of *A. stentoreus*. An identical bird

was seen, and was calling strongly though less frequently, at the same site on 1 February 1995.

These records indicate occurrence of Oriental Reed-Warbler as a vagrant in the Barkly Tableland region.

Conclusions

The four species - Garganey, Swinhoe's Snipe, Oriental Reed-Warbler and White-winged Black Tern - that migrate from Asia and that were recorded in the Barkly wetlands in the period 1993-2002, are each listed under bilateral treaties with China and/or Japan (CAMBA, JAMBA) and the federal Environment Protection and Biodiversity Conservation Act 1999 (Environment Australia 2002b). The Commonwealth and Northern Territory governments therefore have an obligation to protect these species and their habitats. This may have little real implication in the case of vagrant occurrence but, over time, some vagrant species have become or proved to be regular migrants.

In regard to each of the waterbird species reported above, no immediate threats to their occurrence in the Barkly wetlands are known to the author. Future surveys of waterbirds in these wetlands should include searches for nests of Pied Heron and Black-necked Stork in particular, to ascertain the breeding status of these species in the Mitchell Grass Downs bioregion.

Acknowledgments

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Recent records and breeding of Painted Snipe *Rostratula benghalensis* in the Mitchell Grass Downs and Sturt Plateau, Northern Territory.

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Abstract

Three records of Painted Snipe *Rostratula benghalensis* obtained in 1993 and 2001 from the Mitchell Grass Downs and Sturt Plateau biogeographic regions are described. They include the first documentation of breeding by Painted Snipe in the Northern Territory and confirm it as an irregular rather than vagrant visitor to the Territory's wetlands. Habitats for the records comprised coolibah, lignum and grass swamps subject to temporary inundation and under pastoral grazing regimes. The Painted Snipe is listed as Vulnerable under Northern Territory legislation. No immediate threat to the species is known in the regions where it was observed but further surveys, to better understand its status, are recommended.

Introduction

In Australia, the Painted Snipe *Rostratula benghalensis* occurs mainly over eastern parts of the continent, apparently in low numbers (Marchant & Higgins 1993). Lane and Rogers (2000) proposed that the Australian population should be considered a separate species, *R. australis*, from other Old World populations of *R. benghalensis*. Based on a marked decline in reporting rate over the last 40 years (Lane and Rogers 2000), Garnett & Crowley (2000) considered the Painted Snipe to be nationally vulnerable. Painted Snipe has recently been nominated for listing as Vulnerable under *The Environment Protection and Biodiversity Conservation Act 1999* (M. Walkington pers. comm.).

The Painted Snipe has rarely been recorded in the Northern Territory. Apart from the three records described in this paper, the databases of the NT Parks and Wildlife Commission and of Birds Australia include only 16 other records for the Northern Territory: five from the south, ten from central regions and one from the Top End (A. Fisher pers. comm., D. Rogers pers. comm.). Painted Snipe is listed as Vulnerable under *The Territory Parks and Wildlife Conservation Act 2001*.

During 1993-5 and 2001-2, the author was engaged by the Parks and Wildlife Com-

mission of the Northern Territory and Environment Australia to conduct surveys of wetlands and waterbirds in parts of the Mitchell Grass Downs and Sturt Plateau bioregions (Environment Australia 2002a). This involved considerable ground and aerial survey effort in wetlands of the Barkly Tableland during 1993-5 and in June 2001 and April 2002, and a ground survey of wetlands in the Sturt Plateau in May-June 2001.

Sighting and breeding at Tarrabool Lake in 1993

On 19 May 1993, Wayne Zadow and the author found five Painted Snipe on the north-western shore of Tarrabool Lake (18° 14.3' S, 134° 51.8' E). Tarrabool Lake is situated on the blacksoil plains of the Barkly Tableland, in the western portion of the Mitchell Grass Downs bioregion. At the time, the inundated area of the lake was in the order of 200 000 ha due to major floods in February 1993 (Jaensch 1994).

The birds were near a series of shallow pools on gently sloped lake-shore, 10-20 m landward of the current, irregular water line and about 1 m in elevation below the 1993 high water mark. Vegetation comprised open woodland to 5-7 m of Barkly Coolibah *Eucalyptus barklyensis*, over sparse tussock grassland (of an unidentified grass similar to Rat's Tail Couch *Sporobolus mitchellii* but taller) to 0.5 m, and bare ground. Thick tussocks were scattered around the pool edges and on some islets in the pools. Water in the lake and pools was fresh and milky in colour.

On 19 May (late in the morning) the birds were flushed from dry ground and/or pool edges and flew less than 50 m, 1-2 m above ground. On landing, they ran to cover in the shade of trees or among debris, or remained motionless, sometimes squatting. No calls were detected. One bird was an adult female and the others were either males or immatures (Marchant & Higgins 1993). A single male or immature was seen in the same area on 20 May, in mid morning. Key features by which the female was identified were its dark hood and upper chest, medium-length drooped bill and rail-like flight. The other birds had dull grey hoods and spotted upper-wings, backs and tails.

A single Painted Snipe egg was discovered at this locality on 19 May, on dry mud 0.1 m from the edge of a pool that was about 15 m long by 5 m wide and up to 0.4 m deep. The egg was on the shore of the pool (not surrounded by water on an islet or spit), at the base of a clump of unidentified, erect tussock grass that was about 0.5 m tall. There was no nest scrape or materials where the egg was found and the egg was cold. The egg was creamy-white with irregular black blotches that were most frequent and largest at the wide end, but also randomly marked over the whole egg, and there were smaller pale spots in the background. The base colour and markings were noticeably different to those on eggs of Red-kneed Dotterel *Erythrogonys cinctus* and Masked Lapwing *Vanellus miles* observed nearby on the same day. Deciding that the egg was not part of an active nest and probably had been abandoned, and aware of the signif-

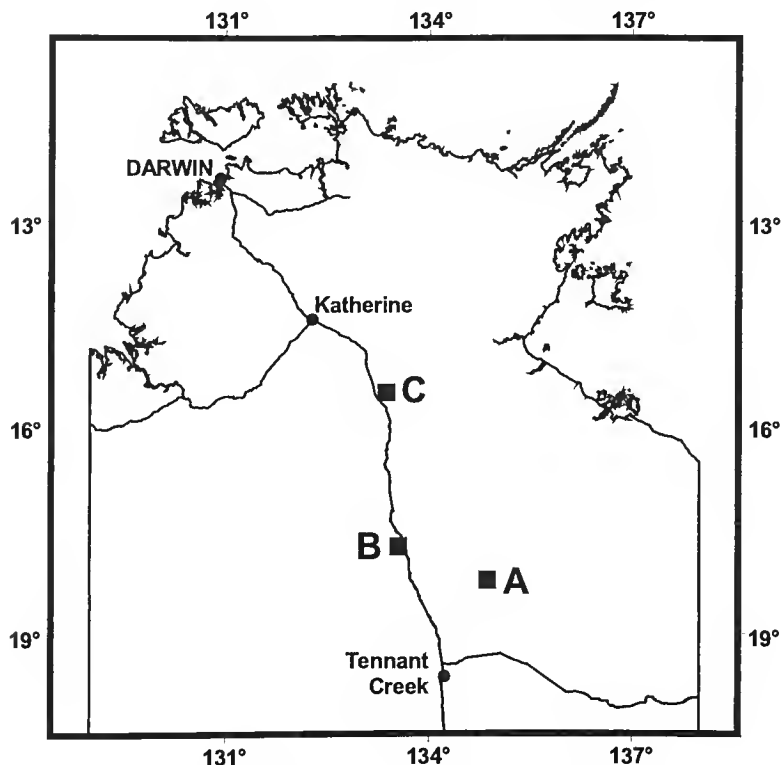


Figure 1. Location of records for Painted Snipe at Tarrabool Lake (A), Lake Woods (B) and Sturt Plateau (C).

ificance of the find, the author collected the egg for lodgement with the Northern Territory Museum (NTMT4341). The egg and habitat were also photographed.

Sighting at Lake Woods in 1993

On 14 December 1993, the author saw a male and female Painted Snipe in swamp on the north-eastern side of Lake Woods (17° 45.6' S, 133° 32.8' E.), which is on the north-western margin of the Barkly Tableland. The wetland covered an area probably exceeding 30 000 ha, having dried back substantially from the maximum extent caused by major floods in February 1993 (Jaensch 1994).

The habitat was inundated open shrubland of *Lignum Muehlenbeckia florulenta* to 1.5 m in height, with profuse fresh growth. Nardoo *Marsilea* sp. formed an almost continu-

ous, lush cover (to 0.1 m height) under and between the lignum shrubs. The clay lake-bed surface was uneven due to 'gilgai' hollows between each shrub, hence water depth throughout this plant community varied from 0 to 0.3 m (mostly around 0.1 m). The water was fresh and varied from clear to milky in colour. Bare muddy or dry areas were at the landward edge of the swamp.

The birds were flushed (in mid morning) from near the base of a sprawling lignum shrub surrounded by inundated dense nardoo, about 30 m from the landward edge of the lignum swamp. They flew 30 m in a lakeward direction, just above or through the lignum shrubs, and landed in similar habitat. A female Painted Snipe that was flushed from the landing area flew to the landward edge of the swamp. The female was identified by its dark upper chest and hood and few spots on the upperparts, whereas the male had a paler chest/hood and prominent golden spots on its upperwings. No calls were detected. The author and Niven McCrie searched unsuccessfully for a nest.

Sighting and possible breeding on the Sturt Plateau in 2001

On 3 June 2001, the author observed two Painted Snipe at a small (ca 20 ha) unnamed swamp in the eastern part of the Sturt Plateau (15° 32.6' S, 133° 22.0' E). The swamp was one of many, mostly unconnected, small swamps on the eastern Plateau that had retained water following major floods in the Wet season of 2000-1.

The habitat for this sighting was the margins of a swamp, where it extended across a 30 m wide laneway, cleared of trees, between parallel fences. The birds were in sparse tussock grassland of Silky Brown-top *Eulalia aurea* (to 0.5 m tall), with regrowth of a few saplings less than 3 m tall. Water among the tussocks was mostly less than 0.1 m deep and there were low dry ridges, created by past grading of firebreaks, and damp muddy areas. Adjacent inundated swamp was dominated by tall bloodwoods *Corymbia polycarpa* and some *Lophostemon grandiflorus* shrubs over dense grassland of Silky Brown-top and sedge *Cyperus procerus*, with central open water to 0.5 m deep. Water was fresh and clear, and the substrate was grey clay.

The birds were flushed several times, flying less than 30 m. One bird, with a complete grey hood, was judged to be probably an adult male but it was not possible to determine the gender or age of the other bird. The male bird was twice seen on bare damp mud having landed after flying in a low arc around the site. On each occasion it spread its wings and held them open, bowed downward, as it remaining motionless. Such a display by this species is sometimes indicative of the presence of young nearby (Marchant & Higgins 1993). The author and Craig Hempel searched unsuccessfully for a nest and juveniles.

Discussion

These three records of Painted Snipe were from diverse wetland habitats - Coolibah wooded swamp and shore, Lignum shrub swamp, and tussock grass swamp. In each case there were bare, muddy open areas and low dense cover of grass/forbs in the vicinity. In two cases the site was part of a particularly large wetland, but the third site was a small wetland. These findings are consistent with the documented wide range of habitats used, alone or in combination, by this species in Australia (Marchant & Higgins 1993).

Previous records of Painted Snipe from the Mitchell Grass Downs bioregion in the Northern Territory are from the middle reaches of the Playford River in 1905/6, from Brunette Creek in April 1906, from the Elliott area (10 km north-east of Lake Woods) in November 1941, and from the Dunmarra area (apparently Milner Lagoon, near the boundary with the Sturt Plateau bioregion) in August 1991 (Storr 1977, PWCNT Fauna Database, Birds Australia Historical Atlas). The total of six records to 2002 may not seem significant. However, the species is notoriously difficult to find in swampy habitat, often exhibits secretive behaviour and is considered to be most active at night (Marchant & Higgins 1993). Few observers visit these wetlands, none regularly. The records to date therefore indicate more frequent occurrence of Painted Snipe in the Mitchell Grass Downs (Barkly wetlands) than might otherwise be assumed.

Until recently there were few breeding records of Painted Snipe in tropical Australia: Marchant & Higgins (1993) mention a record from north-east Queensland and Hassell and Rogers (2002) document records from two localities in the south-west of the Kimberley Division of Western Australia. The Painted Snipe egg found at Tarrabool Lake in 1993, though not a successful breeding effort, nevertheless is the first documented attempt at breeding by the species in the Northern Territory. Additional, though indirect, evidence of possible breeding on the Sturt Plateau was obtained in 2001. The author therefore concludes that Painted Snipe should be considered a non-vagrant, breeding species in the Northern Territory and that further breeding efforts are likely to be detected in the future.

The 1993 and 2001 sightings each occurred several months after particularly large floods on the Barkly Tableland and/or Sturt Plateau. The 1905 and 1906 sightings occurred after average or below-average rainfall in the preceding Wet season; the 1941 and 1991 sightings occurred after average to above-average rainfall in the preceding Wet season (DNR 1997). Occurrence of Painted Snipe in these regions therefore may sometimes, but not necessarily, be linked to major flood events.

The occurrence and breeding of Painted Snipe, a vulnerable species, in wetlands of the Barkly Tableland further underlines the regional and national importance (Jaensch

& Bellehambers 1997, Environment Australia 2002b) of these wetlands for the conservation of waterbirds. The locations of the 1993 and 2001 Painted Snipe records are all from areas under pastoral grazing regimes. It is possible that such grazing, where operated as an ecologically sustainable enterprise, poses no long term threat to continued occurrence of Painted Snipe. Hassell and Rogers (2002) point out that cattle may avoid swamps, to some extent, when the swamps are boggy and water is plentiful. However, information is needed on the possible impact of cattle trampling on active nests.

A decline in Painted Snipe has been documented at a national scale (Lane & Rogers 2000). Records of this species from the Northern Territory are too sparse to assess whether it has similarly declined here, although these records provide evidence of the persistence of the Painted Snipe in the Mitchell Grass Downs and Sturt Plateau. Further field surveys under appropriate wetland conditions are needed in order to monitor the status of this vulnerable species in this part of Australia.

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Plate 1. Habitat where Painted Snipe egg was located at Lake Tarrabool and (insert) close-up of egg. (Photos: R. Jaensch, Wetlands International)

Breeding by Freckled Duck *Stictonetta naevosa*, and a review of recent records, in the Barkly wetlands, Northern Territory

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Abstract

During 1993-2002, Freckled Ducks *Stictonetta naevosa* were recorded throughout the Barkly wetlands of the Northern Territory, most often in the Wet season, in groups of up to 80 birds. Breeding possibly occurred in *Lignum Muehlenbeckia florulenta* swamp in April 1993 and was confirmed in June 2001 when three broods were observed in Cooba *Acacia stenophylla* swamp at Lake Sylvester. This was the first documentation of breeding by Freckled Duck in the Northern Territory. The species is listed as Vulnerable under Northern Territory legislation but there are no known threats to the continued occurrence and breeding of Freckled Duck in the Barkly wetlands.

Introduction

The Freckled Duck occurs in central-eastern, south-eastern and south-western Australia and irregularly in other parts of the continent (Marchant & Higgins 1990). It breeds in some inland and coastal parts of its core range and, according to published accounts (Marchant & Higgins 1990), the most northerly breeding localities are in the Channel Country bioregion (Environment Australia 2002a) in south-western Queensland. It is among the less abundant Anatidae in Australia, with an estimated maximum population size of 19 000 birds (Martindale 1983). This population size varies markedly and probably is much lower in most years (Marchant & Higgins 1990). The Freckled Duck is not, however, listed as a threatened species under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (Environment Australia 2002b) or by Garnett and Crowley (2000).

In the Northern Territory, the Freckled Duck is regarded as a rare or uncommon visitor to southern interior areas and a vagrant in the north (Storr 1977, Blakers *et al.* 1984, Marchant & Higgins 1990). In the Mitchell Grass Downs bioregion (Environment Australia 2002a), Freckled Duck was considered by Parker (1969) to be a regular winter visitor to waterholes in the Brunette Downs area, present in small numbers (up to 160 but usually far less) in most years. It is listed as Vulnerable under the *Territory*

Parks and Wildlife Conservation Act 2001.

Wetlands on blacksoil plains in the Northern Territory part of the Mitchell Grass Downs, from Lake Woods in the west to Lake Sylvester in the east ('the Barkly wetlands'), were substantially inundated during much of 1991-5 and 2000-2. The largest floods, early in 1993 and 2001, created more than 500 000 ha of inundated open lake, wooded swamp, shrub swamp and open shore habitats. A two-person team conducted extensive ground, boat and/or aerial surveys of waterbirds in selected wetlands in both periods: 10 surveys from March 1993 to mid 1995 (Jaensch 1994, Jaensch & Bellchambers 1997) and single surveys in June 2001 and April 2002 (R. Jaensch unpublished data). This work yielded new information on Freckled Duck in the Barkly wetlands, which is summarised here.

Distribution, numbers, seasonality and habitats in the Barkly wetlands

Freckled Duck were recorded in each of the five years of survey during 1993-2002 and, at some time, from each of the major Barkly wetlands (Table 1). Individuals were also sometimes recorded, generally late in the Dry season, at small dams and overflow ponds associated with bores along the Barkly Stock Route. The largest total recorded was 119 birds spread over 3 wetlands on 28-29 March 1994 (Table 1).

Table 1. Highest numbers of Freckled Duck counted at the major Barkly wetlands, 1993-2002, with summary of habitats used.

<i>Wetland</i>	<i>Habitats</i>	<i>Date</i>	<i>Count</i>
Tarrabool Lake	Sand & gravel beach/chenier beside open lake	29 Mar 1994	82
Corella Lake	Delta channels of Corella Creek and associated Lignum swamp	18 Aug 1993	56
Lake Sylvester	Delta channels of Brunette Creek; Cooba/Coolibah wooded swamp	6 Jun 2001	48
Lagoon at Brunette Downs homestead	Waterhole with extensive Lignum	1 Feb 1995	40
Lake Woods	Lignum swamp; open lake; Coolibah wooded swamp	28 Mar 1994	35
Lake de Burgh	Coolibah wooded swamp beside open lake	17 Dec 1993	4
Eva Downs Swamp (end of Cherub Ck)	Cooba wooded swamp	29 Mar 1994	2

Forty dated records of Freckled Duck from the Mitchell Grass Downs and immediately adjacent arid areas, drawn from the fauna database of the Parks and Wildlife Commission of the Northern Territory (A. Fisher pers. comm., August 2002) and recent reports (R. Jaensch unpublished data), were analysed for seasonality. Eighty per cent of the records were from 1993-2002, when at least one survey was conducted in each calendar month except July and October. Of the 40 records, 8 occurred during summer, 21 during autumn, 5 during winter, and 6 during spring. There were 26 records in the Wet season (December to April) and 14 in the Dry.

Freckled Duck were recorded in most of the wetland habitats of the Barkly wetlands (Table 1) except Bluebush *Chenopodium auricomum* swamp. The largest concentrations, usually of a single, loosely associated flock, tended to be at roost sites on beach/chenier ridges or on banks beside the deepest open water in the wetland.

Breeding in the Barkly wetlands

In 1993, Freckled Duck were observed by the survey team at several of the Barkly wetlands in circumstances suggestive of breeding. Two pairs were seen at Lake Woods on 16 April and a male in full breeding colours - including a bright red bill-base - and a closely associated female were seen there in Lignum *Muehlenbeckia florulenta* swamp (17° 44.4' S, 133° 31.3' E) on 18 May. Weight of testes and brightness of bill are correlated (Marchant & Higgins 1990, p. 1171), and the intensity of red bill colour is probably greatest at the breeding site during the early stages of breeding (R. Jaensch pers. obs.). On 21 May, six Freckled Duck, including two males with bright red bills, were flushed from inundated Lignum swamp (18° 48.8' S, 135° 42.6' E) at Lake Sylvester. On each occasion, suitable nest sites in Lignum shrubs to 1.5 m in height, inundated to depths of up to 1 m, were investigated but no active nest or brood of young was detected.

Confirmation of breeding was obtained on 6 June 2001. During a helicopter flight at 50 m height, the author saw three broods - each comprising at least three, non-flying dependent juveniles - of Freckled Duck in the far south-eastern part of Lake Sylvester (18° 52.9' S, 135° 50.6' E). The habitat was Cooba *Acacia stenophylla* tall shrubland with some Coolibah *Eucalyptus barkhyensis* open woodland to about 10 m height and some Lignum, inundated to a depth of about 1 m from an earlier peak of perhaps 1.5 m. The juveniles were judged to be about 60-70% of full-grown size, had partly formed wings and were uniformly pale sandy-grey in colour. They were escorted by at least one adult Freckled Duck per brood. Other waterbirds in the immediate vicinity included Hardhead *Aythya australis*, which has browner juveniles; and Eurasian Coot *Fulica atra*, which has black juveniles. It was not possible to search for nests on this occasion but the Freckled Ducks may have nested in forking trunks of Cooba or Coolibah trees/shrubs near water-level, or in Lignum shrubs. These potential nest sites were common

in the immediate vicinity and elsewhere in the south-east of the Lake. Data on incubation period (28 days) and development of young (full-grown at 56 days: Marchant & Higgins 1990, p. 1170) suggest that in this case clutches may have been completed at the end of March or in the first week of April 2001. Examination of satellite images (Geoscience Australia 2002) shows that such a date may have been close to the date of highest water-level at Lake Sylvester in the 2000-1 Wet season.

Conclusions

Surveys during 1993-2002 have shown that the Freckled Duck occurs throughout the Barkly wetland system, in relatively low numbers (compared with population size), in all seasons but (*contra* Parker 1969) especially in the Wet, and in most wetland habitats.

Breeding by Freckled Duck has been confirmed in the Northern Territory. The broods recorded at Lake Sylvester in June 2001 apparently are also the first confirmation of breeding in all of northern, tropical Australia (Marchant & Higgins 1990). It is likely that at least small numbers of Freckled Duck bred in the Barkly wetlands in 1993 and that breeding at this scale may occur whenever inundation of the wetlands is extensive. The assumed month of laying (probably March) for the 2001 breeding record is not recorded for Freckled Duck in southern Australia (Marchant & Higgins 1993) but reflects typical temporal patterns of wetland availability in northern Australia.

No immediate threat to presumed nest sites or nursery areas of Freckled Duck in the Barkly wetlands is known to the author. No disturbance of active nest sites by cattle would normally occur due to depth of inundation and boggy substrate. Long term effects, if any, on key habitats arising from fire (especially in Cooba stands), from grazing during severe droughts and from continued invasion of the exotic thorny shrub *Parinsonia aculeata*, have not been determined. Managers of grazing leases are currently addressing some of these issues in conjunction with government agencies.

Further studies on waterbirds in the Barkly wetlands should include more effort to locate nests or broods of Freckled Duck. Identification of preferred diet and habitat for feeding would also enhance conservation management of Freckled Duck in the Barkly wetlands.

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Craig Hempel; field assistants Wayne Zadow, Chris Johnson, Niven McCrie, Brice Wells and Keith Bellchambers; and managers of the relevant pastoral leases.

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Additional records of the Carpentarian Rock-rat *Zyomys palatalis* at Redbank, close to the type locality

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Despite extensive survey effort in the Gulf region (Menkhorst & Woinarski 1992, Trainor 1996, Churchill 1996, Puckey unpubl. data) the Carpentarian Rock-rat *Zyomys palatalis* is known from only four locations, all on Wollgorang Station (Moonlight Gorge, Banyan Gorge, Camel Creek Gorge and McDermott's Springs). All four locations are within a 37 km radius and the closest of the four sites are 17 km apart. Habitat at all locations is typified by monsoon forest vegetation on scree slopes within sandstone gorges and associated with permanent water. Due to the low population size of *Z. palatalis*, the limited availability of suitable habitat, and the vulnerability of preferred habitat to damage by fire, the species is listed as critically endangered, and specified in the list of threatened species referred to in section 178 of the *Environment Protection and Biodiversity Conservation Act 2000*. In the Northern Territory the Carpentarian Rock-rat *Zyomys palatalis* is defined as Threatened under section 30 of the *Territory Parks and Wildlife Conservation Act 2000*.

In 2001 I received photos and hair samples from the caretaker of Redbank Mine (17°11'S 137°46'E) indicating that Carpentarian Rock-rats occurred in the scree slopes adjacent to the mine camp. In February 2002 (late wet season) the Redbank Camp site was trapped for two consecutive nights. A total of seven *Z. palatalis* individuals (4 males and 3 females) were recorded from only 180 trap nights. Two of the females were heavily pregnant.

The habitat at Redbank Camp includes a patch of monsoon forest within a small sandstone gorge with a permanent spring. On either side are open woodland, scree slopes and rock walls. The area of monsoon rainforest is less than 1 ha in size and is dominated by *Syzygium angophoroides* with a canopy height of up to 12 m and canopy cover of 50-70%. Many of the plants present in the rainforest patch are common with the type location (Banyan Gorge) and include *S. angophoroides*, *Exocarpos latifolius*, *Celtis philippensis*, *Antidesma parvifolium*, *Flueggea virosa*, *Ficus opposita*, *F. virens*, *Timonius timon*, *Alphitonia excelsa* and *Passiflora foetida*. The surrounding savanna woodland is dominated by *Eucalyptus brevifolia*, with *Erythrophloeum chlorostachys*, *Owenia vernicosa*, *Terminalia carpentariae*, *Grewia retusifolia* and an understorey of *Triodia* spp. Some trees, shrubs and vines were

fruiting at the time of trapping including *F. virosa*, *A. parvifolium*, *T. carpentariae*, *Ficus* spp., *P. foetida*, *S. angophoroides* and *T. timon*. The site has substantial scree slopes as well as rock walls with caves and fissures, similar to the type location.

The level of human impact on the Redbank site is considerable. Due to its proximity to the residential area, it is burnt annually with hot fires to reduce fuel loads and to protect infrastructure (Tony Inwood, Redbank Mine, pers. comm.). Although these fires do not appear to penetrate far into the gorge proper, they do burn the surrounding scree slopes where most of the rats were caught during this survey. Movement of people, equipment and vehicles in the area has facilitated the spread of non-native plants (*Mangifera* sp., *Hyptis suaveolens* and other garden plants) onto the scree slopes and up to the gorge entrance, and has facilitated the aggressive spread of *Passiflora foetida*. Rainforest patch sizes across the Gulf region have been found to be vulnerable to continued disturbance from introduced weeds and intense late-dry season fires (Russell-Smith and Bowman 1992). Begg *et al.* (1981) showed a decrease in the numbers and fecundity of another species of large rock-rat, *Z. maini*, after fire. The rats at Redbank have been observed foraging in and around the human residences (T. Inwood pers. comm.) where they may be supplementing their diet with non-conventional foods, especially when fire has disturbed their natural food source.

The Redbank site is 7 km from the nearest known population of the species (Banyan Gorge). This raises the question of whether individuals move between the populations or whether populations exist as isolated units. Recent radio-tracking studies indicate that the rats are capable of travelling approximately 2 km from their point of capture in just one night and that this travel is not restricted to habitat within the gorge environment (Helen Puckey unpubl. data, 2001-2). Therefore it is not unreasonable to expect that the rats may indeed be moving between Redbank and Banyan Gorge.

The Redbank site had been previously trapped in the dry season of 1993 (Churchill 1996). No *Z. palatalis* were recorded during the earlier study despite a much greater trapping intensity (432 trap nights). Trainor (1996) found that capture rates of *Z. palatalis* were strongly seasonal with significantly fewer captures in the early dry season (July – August). This highlights the need for trapping in both wet and dry seasons. It also raises the question of whether *Z. palatalis* populations are susceptible to decadal-scale changes in climate, similar to the Central Rock-rat *Z. pedunculatus* which is now showing a much greater distributional range after a series of good rainfall years (Glenn Edwards, Parks and Wildlife Service NT, pers. comm.). Mean annual rainfall recorded at Wollogorang was 41% less in the 5 years leading up to the 1993 survey, than for the 5 years prior to the current survey at the same site (data from Bureau of Meteorology). Surveys of other gorges in the immediate area would provide good comparisons with baseline surveys carried out in 1993-1995 and help to clarify the current distribution of the species.

Acknowledgements

Thanks to Jodie Gogler, Nerida Holznagel, Milton Lewis and Dave Hooper for help in the field. John Woinarski and Glenn Edwards provided comment on the manuscript. Thanks to Val and Tony Inwood at Redbank mine for their hospitality and for taking an interest in the rats.

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Range extension for the White-striped Freetail Bat *Tadarida australis* in the Northern Territory, from Anabat recording

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Microchiropteran bats echolocate using ultrasonic vocalisations that are distinct and diagnostic for many species. As a consequence bat detectors provide an effective and accurate means to survey and identify free-flying bats (e.g. Law *et al.* 1999, Young and Ford 2000). This is particularly true for species that are high-flying and forage above the tree canopy, so are rarely caught by traditional trapping techniques. Here we describe a significant range extension for one such species, resulting from surveys using Anabat detectors.

At 9.30pm on the 20th May 1999, KN recorded a series of bat call sequences on Killarney station (16° 28' S 131° 55' E; Figure 1) during a quadrat-based census. The census, involving approximately 18 hours of recording across 107 sites, formed part of a vertebrate fauna survey of the Victoria River region of the Northern Territory. Bat calls were detected using a hand-held Anabat II detector (Titley Electronics, Ballina, NSW) and recorded directly to audio cassette. The calls were subsequently analysed using zero crossing analysis and Analook software (Corben & O'Farrell 1999).

The characteristic frequency (cf. de Olivera 1998) of one call sequence was measured between 11 and 12 kHz (Figure 2), much lower than calls recorded from any of the bat species known to occur in the Top End (Milne 2002). We attributed this call sequence to the White-Striped Freetail Bat *Tadarida australis*, a large molossid bat that occurs primarily south of the Tropic of Capricorn (Churchill 1998). The sequence was identified by examining a set of unpublished reference calls and confirmed by a number of bat experts around Australia. The call is also consistent with that described for *T. australis* by a number of other sources (Fullard *et al.* 1991, Herr & Klomp 1997, McKenzie & Muir 2000). We regarded the call sequence as appropriate for analysis due to its regular and consistent pulse shape over an extended period (15 seconds).

Tadarida australis has not previously been reported from the tropical savannas of the Northern Territory, this record representing a northerly range extension of c. 400 km. Killarney Station lies on the margins of the Sturt Plateau and Victoria River basin and is predominantly flat to undulating rises, with eucalypt savanna on red calcareous loam

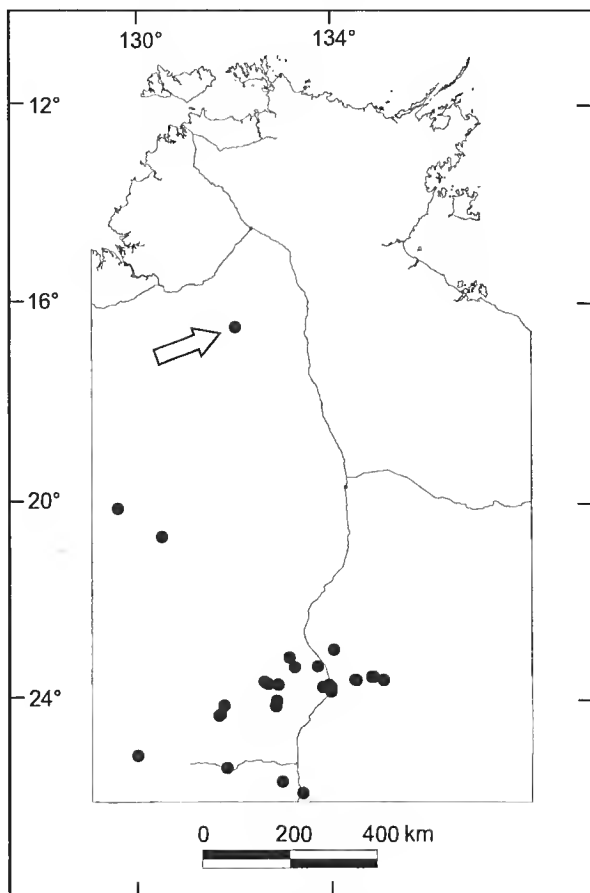


Figure 1. Previous records of *Tadarida australis* in the Northern Territory (PWCNT Fauna Database) with the new record from Killarney Station indicated by an arrow.

soils. The vegetation at the recording site was low open woodland dominated by *Eucalyptus pruinosa*, with a canopy height of 6-7 metres.

Discussion

Although considerably north of all previous N.T. records (and possibly the most northerly record in Australia), this record of *T. australis* may not indicate a disjunct population. Rather, it likely reflects the inadequate survey effort for bats and paucity of all bat records throughout the northern N.T. In northern Queensland, a specimen of *T. ans-*

tralis was recently collected at Atherton ($17^{\circ} 16' S$ $145^{\circ} 29' E$) in August 1998 (Anon 2001). However, the most northern specimen of this species held by the Queensland Museum was collected from Mt. Carbine ($16^{\circ} 32' S$ $145^{\circ} 08' E$) around 1943.

The date of our observation (late May) is consistent with the suggestion that *T. australis* may migrate north during the southern Australian winter (Churchill 1998, Lumsden 1999). Although common at other times, this species is apparently virtually absent from Victoria between June to August (Churchill, 1998).

One caveat to our identification of the Anabat call sequence is the possibility that the call may have been produced by *Saccolaimus saccolaimus*, for which there are no published reference calls. This species is known to occur in the Northern Territory (McKean *et al* 1981), although has not been detected for many years. McKean collected specimens by listening for their high-pitched, audible sonar clicks and locating them with a spotlight before they were shot (A. Hertog pers. comm.). Therefore, it is likely that *S. saccolaimus* has an audible echolocation frequency at or below 20 kHz. While we cannot rule out the possibility that the call we recorded may be attributable to this species, the similarity to calls recorded for *T. australis* from elsewhere in Australia is compelling.

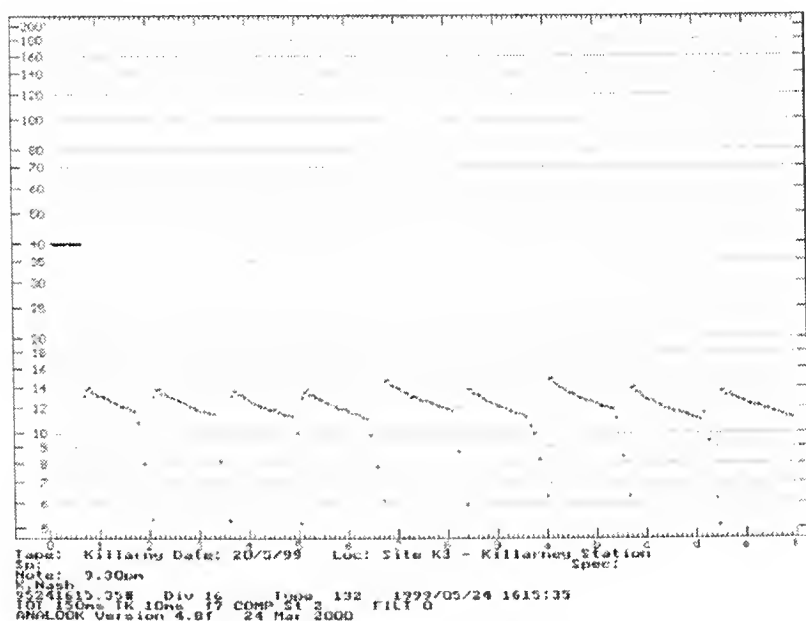


Figure 2. Analog display showing portion of the call sequence identified as *Tadarida australis*. There was minor editing of the sequence to show the calibration tone.

We recommend the continued use of ultrasonic detection and identification systems, in concert with traditional trapping methods, to survey areas where the bat fauna is poorly known. Along with the refinement of a comprehensive Anabat call reference library for bats of the Northern Territory (Milne 2002), this will continue to provide a better understanding of the distribution patterns of Australian bats and enable us to better conserve and manage this poorly studied group.

Acknowledgments

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Occurrence of the Yellow Plum *Ximenia americana* L. as a tidal strand-line plant in Darwin Harbour

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The shrub *Ximenia americana* L. (Olacaceae) has a pantropical distribution. In keeping with its wide occurrence it has an array of common names including Yellow Plum, Hog Plum, Monkey Plum, Niaraguan Plum, Sea Lemon, Bush Lemon, Tallow Nut, Tallow Wood, Gotoobah and Wild Aprieot. It also has the distinction of being the first recorded western identification of any plant in Australia, this being made on 21 September 1606 by Don Diego de Prado y Tovar, a member of Torres's expedition. That plant was observed on an island, possibly Long Island, in Torres Strait (Windolf 2000). Until recently, all Australian records were from Queensland (George 1984), but Liddle *et al.* (1994) recorded it from five coastal localities in the Northern Territory. In this note, we report a new locality for the species, Talc Head (12°29' S, 130°47' E) in Darwin Harbour, 75 km south-west from the nearest previously reported location at Cape Hotham. A collection, *C.P.Mangion and D.C.Franklin 1080*, is lodged in the Northern Territory Herbarium.

Aboriginal people from Darwin and Belyuen knew of *X. americana* at Talc Head. This information was passed to the Talc Head manager, Duncan McRae, who in turn drew the plant to the attention of members of the local scientific community including ourselves. Two plants have been located, 50 m apart, both just above the high-tide mark of the Mandorah-side beach below the Talc Head hostel. Both are growing on white beach sand at the base of small kaolinite cliffs. One of these "plants" has four distinct stems which may be separate plants or perhaps the product of suckering or layering. Both occur in coastal vine-thicket, in which some of the component species frequently occur on tidal strand-lines and others are generalist vine-thicket plants (Table 1).

Ximenia americana is a spreading semi-parasitic scandent shrub to 5 m tall with branches bearing thorns. Stems curve out and down, possibly promoting layering. The leaves are elliptic to obovate, to 50 mm long or sometimes longer. The 25-50 mm long fruits bear a strong but superficial resemblance to miniature lemons, but are drupaceous, comprising a single hard-walled seed container (a "stone") surrounded by a relatively thin fleshy outer layer (exocarp) which is yellow when ripe. The flowers are small and white or pale yellow (George 1984). At Talc Head, the plants observed were 5 m tall

by 5 m across and 3 m tall by 6 m across respectively, with prominently wavy margins to the leaves. Information from herbarium specimens, personal observations and those of D. McRae indicate that *X. americana* flowers and fruits sporadically throughout the year.

All Northern Territory collections of *X. americana* are coastal, and most are from Co-bourg Peninsula eastwards. At least three are of isolated individuals which grow immediately above the tidal strand-line (G. Wightman pers. comm.), although in Queensland the species is by no means confined to the tidal strand-line nor even coastal districts (George 1984). Isolated tidal strand-line occurrences suggest fruit dispersal on ocean currents, a feature confirmed by Guppy (1906), Pike & Leach (1997) and Smith (1999).

Table 1. Plants associated with *Ximenia americana* at Talc Head. Species marked with an asterisk are frequently associated with tidal strand-lines.

Species	Common name
<i>Abrus precatorius</i>	Crabs-eye Vine
<i>Acacia holosericea</i>	Candelabra Wattle
<i>Aidia racemosa</i>	Archer Cherry
<i>Bambusa arnhemica</i>	Top End Bamboo
<i>Capparis sepiaria</i>	Wild Orange
<i>Celtis philippensis</i>	Celtis
<i>Cordia subcordata</i> *	Sea Trumpet
<i>Denhamia obscura</i>	Orange Root
<i>Dioscorea bulbifera</i>	Round Yam
<i>Drynaria quercifolia</i>	Basket Fern
<i>Drypetes deplanchei</i>	Grey Boxwood
<i>Flagellaria indica</i>	Supplejack
<i>Flueggea virosa</i>	White Currant
<i>Glycosmis trifoliata</i>	Pink Lime
<i>Hibiscus tiliaceus</i> *	Beach Hibiscus
<i>Hypoestes floribunda</i>	Rosy Hypoestes
<i>Lindsaea ensifolia</i>	Common Wedge Fern
<i>Lysiphyllum binatum</i>	
<i>Memecylon pauciflorum</i>	
<i>Mimusops elengi</i> *	Red Condoo
<i>Notelaea microcarpa</i>	Small-fruit Mock-olive
<i>Pachygone ovata</i>	
<i>Premna acuminata</i>	
<i>Psychotria nesophila</i>	Gabu
<i>Scleria lithosperma</i>	
<i>Stenocarpus verticis</i>	
<i>Strychnos lucida</i>	Strychnine Tree
<i>Tacca leontopetaloides</i>	Polynesian Arrowroot
<i>Trophis scandens</i>	
<i>Zanthoxylum parviflorum</i>	Prickly Tree
<i>Ziziphus oenopolia</i>	Wine Jujube

Guppy (1906) also noted that frugivorous birds consume, and may thus disperse the fruits, which presumably accounts for its non-coastal occurrences in Queensland.

The fruit of *X. americana* is reported to be refreshing and tasty to eat if collected after falling, but astringent whilst still on the tree (D. McRae pers. comm.). It is sought out by Aboriginals from Belyuen (D. McRae pers. comm.), and also on Cobourg Peninsula (Blake *et al.* 1998). In Africa, it is also a favoured bush food. The seeds are rich in iodine-bearing oils (Eromosele *et al.* 1994), but may be poisonous (Smith 1999). The young leaves are edible after cooking (Cribb & Cribb 1974). In Fiji, the fruit and timber is utilised. It is also a significant bush medicine, and stem bark extracts have shown positive indications as a treatment for the HIV AIDS virus (Asres *et al.* 2001).

Acknowledgements

We are grateful to Duncan McRae for drawing our attention to the plant and providing information about it. Mark Hamann provided boat transport to revisit the site. Glenn Wightman identified the plant, and he and Phil Short commented helpfully on the manuscript.

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First record of the Metallic Starling *Aplonis metallica* in the Northern Territory

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Two Metallic Starlings *Aplonis metallica* were observed by the author in a suburban garden in Millner, Darwin, on the morning of 5 August 2002. They were kept under observation from about 9.30 to 9.40 am with the aid of binoculars (10x), during which time they moved quietly and unhurriedly in and below the crown of an unidentified rainforest tree approximately 9 m high. At least one bird was visible for most of the ten minutes of observation. My observation point varied from about 7 to 10 m from the base of the tree, with the sun directly behind me. The birds moved in and out of bright sunlight against a background of dense foliage of the rainforest tree, large clumping bamboo and a *Schefflera* tree. Viewing conditions were optimal with bright illumination and without glare or silhouetting against the sky.

The birds were an adult and immature or subadult. The adult bird was the first seen, and was most visible during the period of observation. The subadult bird appeared lower down in the same tree and was seen in full view for several minutes. The Starlings appeared to be foraging in the tree, which was fruiting, but I was unable to confirm whether they ate any of the fruit. Several Figbirds *Sphecotheres viridis* and a Yellow Oriole *Oriolus flavocinctus* were observed feeding on fruit in the same tree while the Starlings were present. While the subadult bird remained in the shade in the lower canopy, the adult remained high in the canopy, moving through the foliage and perching in full sunshine for about four minutes on a prominent horizontal branch extending beyond the canopy of the tree. The adult flew suddenly from the tree giving a subdued call, comprising a single short, rising note: 'chirrp'. The birds were otherwise silent.

The author is familiar with the Metallic Starling and close relatives, which I have observed in eastern Cape York, Papua New Guinea and eastern Indonesia. The size, shape of tail and highly iridescence plumage ruled out possible confusion with the Spangled Drongo *Dicrurus bracteatus*.

The Metallic Starling does not appear to have been recorded in the Northern Territory previously, and I therefore provide a description of the birds, based on notes taken at the time. These notes were made immediately after observing the birds, and prior to consulting the standard field guides (Slater *et al.* 1989, Strahan 1996, Pizzey & Knight 1996, Simpson & Day 1999).

Adult

Length: 20-22 cm. Tail relatively long with pointed feathers. Entire plumage glossy black with lanceolate feathers on neck and upper breast. Rich iridescent purple sheen with green tints, particularly on neck, upper breast and crown. Prominent eye, noticeably bulging when viewed front on; iris brilliant vermillion.

Immature or Subadult

Same size and general shape as adult. Dark brownish black dorsally, crown blackish. Pale ventrally, with clear white belly and under tail coverts, rather duller on breast and throat; breast and sides of belly boldly streaked in dark brown, with streaking becoming finer and denser on upper breast, throat and chin, giving an overall dark appearance to chin and throat. Iris russet.

The description of the adult is consistent with the field guides cited above. The description of the subadult is consistent with published accounts of immature birds except for the darker throat and iris colour.

The Metallic Starling is commonly encountered in flocks in rainforest, parks and gardens in eastern Cape York peninsula. The species is also widespread in New Guinea and most satellite islands, the Solomon Islands, and the Maluku region of eastern Indonesia (Beehler *et al.* 1986, Coates 1990, Coates & Bishop 1997). This record of the Metallic Starling in Darwin is at least 1,000 km west of its normal Australian range. The nearest population to Darwin is on the islands of Tanimbar (c. 500 km north of Darwin) and Damar in south Maluku, where Coates & Bishop (1997) consider it to be uncommon to rare. The south Maluku population was considered by White and Bruce (1986) to constitute a separate subspecies, *Aplonis metallica circumscripta*, which is distinctive in the whole head to upper back and chest being bright reddish violet, with only a little green on the lower throat and upper mantle. The above description of the Darwin adult is not inconsistent with subspecies *circumscripta*, but is insufficient to distinguish it from the Australian form. The subspecific identity of the Darwin birds must therefore remain inconclusive, and provides no evidence of their possible origin.

Australian populations of the Metallic Starling migrate between Cape York Peninsula and the New Guinea mainland, arriving in Australia in July or August to breed, and departing to New Guinea in February to April (Coates 1990, Draffan *et al.* 1983, Pizzey & Knight 1996, Simpson & Day 1999). It appears that regular migration does not occur elsewhere in the species' range, and New Guinea populations may be highly nomadic (Coates 1990). Breeding has been recorded in Papua New Guinea in all months, but with most records between July and October (Coates 1990, p. 356). I have recorded the species breeding in October in the Aru Islands south of the Papuan (Irian Jaya) mainland in Indonesia. There appears to be no available data on the move-

ments or breeding times of populations in the Maluku range of the species (cf. Coates and Bishop 1997).

If the Darwin birds were vagrants from Cape York, the subadult most probably would be at least one year old, as breeding in Australia does not normally commence until August, and this is also likely the case if the birds were vagrants from New Guinea. On the basis of proximity, the Darwin birds were perhaps more likely to be vagrants from the poorly understood populations in south Maluku, while the New Guinea mainland is also a possible source given the regular migration south in July-August. However, on the available evidence the origins of the Darwin birds must remain a matter of speculation.

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Species Profile: Black-footed Tree-rat

scientific name: *Mesembriomys gouldii*

family: Muridae

The Black-footed Tree-rat is an aboreal rodent confined to the tropical savannas of Cape York, the Top End of the Northern Territory and the northwest region of the Kimberley. The species is considered to be uncommon to rare in Queensland and the Kimberley, but still common within a patchy distribution in the Northern Territory (Fig. 1). The species has not recently been recorded from eastern Arnhem Land or the Gulf of Carpentaria, suggesting there may have been some contraction in distribution.

Weighing up to 900g, the Black-footed Tree-rat is one of Australia's largest rodents. They have a robust body with grey-black fur, darker feet and large ears. Their most distinctive feature is a long tail, about 30-40cm in length, which has a brush of white hairs at the tip. Although considered to be solitary, during a recent research project a number of radio-collars on the tree-rats were gnawed, which could not have been done

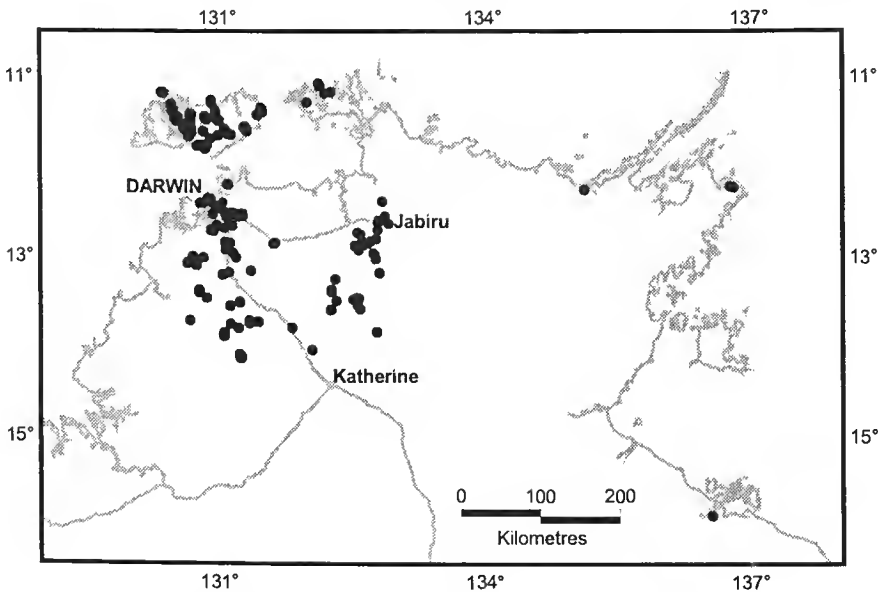


Figure 1. Distribution of the Black-footed Tree-rat in the Northern Territory (source: PWCNT fauna database).

by the collared animal. This suggests that individuals are interacting on a more regular basis than previously thought.

Breeding occurs throughout the year with a peak in the late dry season. They have a relatively long gestation period of 43-44 days, with one to three young per litter. The young grow rapidly and are weaned at approximately 4 to 5 weeks when they weigh about 400g. The male has no role in the parental care of the young.

Being nocturnal, the Black-footed Tree-rat prefers to nest in tree hollows during the day, but has also been recorded nesting in pandanus where hollows are limited. A current study near Darwin has found individuals to use between one and six different den trees, with each individual having its own set of trees. The most notable feature of den trees is their large basal diameter - the average diameter (at breast height) of den trees used by Black-footed Tree-rats in the current study is 42.4 cm.

Although their diet is not well known, Black-footed Tree-rats appear to prefer fleshy and hard fruits and seeds, with pandanus fruit being particularly favoured. Foraging both in the trees and on the ground, they can cover large distances in search of food resources. The current study has recorded them covering distances of 2km in a night. The patchy distribution of many suitable fruiting species (eg. *Pandanus*, *Planchonia*, *Terminalia*, *Gardenia* spp.) is believed to be one factor responsible for the patchy distribution of the tree-rats.

The Black-footed Tree-rat is one of a number of mammal species in the tropical savannas that has declined in distribution and abundance since European settlement. Speculation about the cause of this decline centers upon changes in fire regimes, with the cessation of traditional Aboriginal burning regimes and the predominance of frequent, broad-scale fires. Not only has fire been shown to greatly decrease the survival of the larger diameter trees preferred by Black-footed Tree-rats, but frequent fire also changes the structure of the midstorey, reducing the survival and abundance of many important fruiting species.

The Black-footed Tree-rat is currently the focus of a research project being undertaken by the Key Centre for Tropical Wildlife Management (Northern Territory University) and the Parks and Wildlife Commission of the Northern Territory.

The Black-footed Tree-rat is illustrated on the back cover of this edition.

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- Begg R.J. (1988) Sandstone Antechinus. In *The Australian Museum Complete Book of Australian Mammals* (ed. R. Strahan), pp. 30-32. Angus & Robertson, Sydney.
- Menkhorst K.A. and Woinarski J.C.Z. (1992) Distribution of mammals in monsoon rainforests of the Northern Territory. *Wildlife Research* 19, 295-316.

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